Table 13

Rainfall at Manatee, Florida in 1946

| Date | Total Monthly Rainfall in Inches |
|---|---|
| January | 1.86 |
| February | 4.24 |
| March | 1.69 |
| April | .23 |
| May | 2.09 |
| June | 5.65 |
| July | 6.76 |
| August | 8.57 |
| September | 10.41 |
| October | 3.00 |
| November | .85 |
| December | .76 |

The above table shows that rainfall at Manatee was heavy throughout the summer months. Rainfall of less than 1 inch per month is considered insufficient to keep sansevieria growing even though temperatures and other factors may be favorable.

**Manuscripts of Sansevieria Papers by J. Frank Joyner**

# SANSEVIERIA REPRODUCTION FROM SEED

It is generally known that most species of sansevieria produce but few seeds or none at all. A review of the literature on sansevieria furnishes but little information regarding the production of seed by this plant. Augusto Perez Toro(1) states that sansevieria may be reproduced from seed but that the plants grow slowly and are unsatisfactory for fiber. No details are given. Ricardo Loret De Mola(2) mentions that sansevieria can be grown from seed but gives no details. The lack of information on this subject indicated the advisability of initiating a series of experiments in growing sansevieria from seed, for the purpose of obtaining additional information concerning the growth habits of the different species now being grown experimentally in the United States for the production of fiber.

---

1. Augusto Perez Toro. El Cultivo de la Sansevieria in Yucatan. p. 16. 1942.

2. Ricardo Loret De Mola.

It was apparent that more complete data on this subject would be useful not only in connection with the utilization of these plants for the production of fiber, but also from a horticultural viewpoint. Relatively large quantities of certain species of sansevieria are now grown by horticulturists for use as ornamental household plants. There is a large demand for these plants, and any new facts relating to the growth habits of the species used as ornamentals would be useful in this field. The experiments in growing sansevieria plants from seed were undertaken as a part of a sansevieria investigational project started in 1943, and conducted by the United States Department of Agriculture and cooperating agencies near Boynton, Florida. This paper covers only preliminary results obtained in experiments that are still in progress.

The principal species now being grown for fiber in the experimental work near Boynton is *Sansevieria metallica*. Though indigenous to Africa, this species now occurs in patches of wild or semi-wild plants throughout South Florida on both the east and west coasts. It may also be found in many door-yards where it is grown as an ornamental plant. It does not produce any seed under Florida conditions. It is not known if seed is produced by this species in its native habitat in Africa. The flowers of some plants produce abundant pollen, but in most flowers the pistil has been reduced to a pistillode which remains sterile. A few *linocarps* have been found on several wild plants indicating that development of the seed had begun but was not completed.

In contrast to S. metallica, the two principal ornamental species S. zeylanica and S. lorentii both produce seed though lorentii has been found with seed in only one locality in Miami, Florida. Seed production is rare, however, even with the ornamental species. The Florida growers of sansevieria plants that are to be used for ornamental purposes obtain their new stocks by asexual methods of propagation, and are not familiar with seed production.

Seeds have been found on A. zeylanica in Miami, Arcadia and Sebring, indicating that this species seeds more freely than A. lorentii, though the latter grows as freely and vigorously in these places as does zeylanica. One other species, not yet definitely identified, but probably S. longiflora or S. rotundaflora, at Sebring, Florida, also produces seed. The seeds of this species were not ripe when the plants were last inspected on August 20, 1944. One plant of A. zeylanica in the experimental plots produced fruit in September, 1944, but the fruits have not yet reached maturity (fig. ?).

In June, 1943, 25 seeds were obtained from plants of S. zeylanica in Arcadia, Florida. These seeds had been ripe for some time and 15 were partly shriveled. These 25 seeds were planted on June 19, and 6 of them germinated during the last week of July. No further germination was obtained with this lot of seed, probably due either to imperfect fertilization or to the fact that the seed had dried out sufficiently to kill the embryo.

Two other lots of seed that had been received from the American Consulate, Nairobi, Kenya, Africa, were also planted on June 19. The first lot, under P. I. number 146175, contained 32 seeds. On July 8, six of these seeds had germinated, and on July 31, fourteen plants were above ground. At this time these plants were sufficiently large for transplanting from the seed bed to pots. No further germination was obtained from this lot of seed. The second lot, under P. I. number 146174, contained 10 seeds. On July 8, six of these seeds had germinated. No further germination was obtained from this lot. The species of sansevieria from which these two lots of seed were obtained is not known. Photographs made of these plants on September 18, 1943, indicate that the seeds in these two lots were obtained from the same species. There are, however, marked differences between the African plants and those of *S. zeylanica*, which are shown by the leaves of the seedlings even in the very early stages of development. *S. zeylanica* has a narrow leaf with a sharp pointed tip, whereas the African species has a broad leaf with a distinct marginal border, and with the apex much less pointed than in *zeylanica*. Another contrasting feature of the two species is the finely mottled upper surface of leaves of the African type, whereas the leaves of *zeylanica* have a smooth upper surface entirely without spots.

A second lot of seed of *S. zeylanica* and *S. lorentii* was obtained in Miami, Florida, on July 15, 1944. Fifty seeds of *S. zeylanica* and 6 seeds of *S. lorentii* were planted on July 17, 1944. On August 5, forty-five seeds of *S. zeylanica* and 4 of *S. lorentii* had germinated. All of these seeds were freshly ripe when gathered and doubtless this factor contributed to the high percentage of germination.

## LENGTH OF TIME REQUIRED FOR GERMINATION

About six weeks was required for the germination of the seeds of S. zeylanica obtained from Arcadia. Six seeds of one lot of the African species germinated in three weeks, and six weeks after planting 14 plants of this group were sufficiently large for transplanting from the seed bed to pots. Six plants of the second lot of African seed had emerged in less than three weeks after planting, indicating a much shorter germinating period for the African seed as compared with that of the S. zeylanica, from Arcadia. However, the Miami lot of seed of S. zeylanica compared favorably with the African seed in length of time required for germination.

## DEVELOPMENT OF SEEDLINGS

Seedlings from the first lot of Arcadia seed were potted in 2-inch pots when 30 days old and placed outdoors in a half-shade. The plants grew rapidly for a few weeks until the first six or eight leaves had formed, and then they grew very slowly for a period of nearly eight months. This slow growth doubtless was prolonged by the rather cold nights of the winter months, and the fact that the plants remained in small pots. At the end of one year these plants were still small with only six to ten leaves, typically rosette in form. In July, 1944, the plants were transferred to 4-inch pots and rapid growth began. The characteristic color of the "character" leaf was distinctly visible in the S. zeylanica by September, and the leaves began to assume a more upright position indicating the beginning of the formation of petioles that are a part of the "character" leaf. By this time a large mass of fibrous roots had been formed on the plants.

## PREPARATION OF SEED BED

The seed bed consisted of light sand mixed with one part muck. This soil mixture was placed in a flat to a depth of four inches when firmly pressed down. The seeds were planted one inch apart in check rows and were pressed into the soil and very lightly covered with soil firmly pressed down. Before planting, the seeds were cleaned of all pulp by washing in warm water. The seed flat was kept in a half-shade and the soil was kept moist at all times, but not soggy, until germination of the seeds was complete.

## JUVENILE ROOT SYSTEM

When germination begins, two roots resembling small tap roots emerge almost directly from the seed. These roots grow about two inches long and are a typical orange-red color. At this stage of growth most of the plant's nourishment is still supplied by the slowly digesting seed. After the shoots appear above ground a few additional roots are formed, but several weeks elapse before the fine lateral roots begin to branch out from the minature tap roots. During this period the plants grow slowly. As more lateral roots develop, rapidity of growth increases and when a large mass of fibrous roots has been formed the plants begin to grow very fast. During the stage when the mass of fibrous roots is being formed, there is no sign of the appearance of rhizomes. When leaf cuttings are rooted, no long vertical roots are formed, but only short white roots that are soon followed by branching lateral roots. The fibrous roots thus formed are soon followed by the formation of rhizomes which, in turn, produce a new shoot above ground. The fundamental difference between seed-produced plants and plants produced from leaf cuttings is that seedling plants produce no rhizomes before "character" leaves are formed.

## DESCRIPTION OF FRUIT AND SEED

The green fruits of S. zeylanica are about one-fourth inch in diameter. At maturity the seed is covered with a very thin fleshy pulp. In Arcadia, Florida, the plants bloom in January and February and the fruits ripen in late June and early July. Once the fruits begin to ripen only a few days elapse before they are completely ripe. When fully ripe the fruits are a bright orange-red color, and usually remain on the plant for only a few days before dropping. A normally matured fruit contains three cells with each cell containing one seed, but most of the fruits that have been found were either single or double-celled. After the fruit is ripe the thin soft pulp separates readily from the seed which is white in color, hard, and slightly oval in shape. Like many of the palm seeds, the seeds of sansevieria are composed largely of albumen and a slow germination would, therefore, be expected. The surface is smooth and the embryo is readily visible to the naked eye as a minute dark-colored spot, sometimes slightly elevated above the surface of the seed and very shallow. This indicates that the seed would be very perishable if allowed to dry out for any appreciable length of time. The poor germination of the sansevieria seed received from Africa may have been partly due to excessive drying out during transit.

## JUVENILE LEAVES

As indicated elsewhere, germination takes place rather rapidly. The first two or three leaves appear above ground as bladeless sheaths followed in turn by succeeding leaves, very minute at first, but each leaf slightly larger than the one preceding, until the juvenile leaves reach full size. At emergence, the leaves are almost vertical but as they grow older they spread out and assume a more horizontal position, giving the plant the characteristic "rosette" form. This rosette form is a definitely juvenile character and the plants remain in this stage for many months before upright leaves are formed, even though the character leaf may be distinguished in the rosette stage. Another feature of juvenile leaves is that they have no petiole as do the adult upright leaves. The length of the juvenile period will vary under different conditions of growth, but at least two years will probably be required before upright leaves with full petioles are formed. It is likely that true upright leaves will not form until rhizomes are produced. Since only upright leaves are suitable for fiber, this characteristic feature of young seedling plants having only rosette leaves renders the use of seed undesirable as a propagating material where an early upright leaf is desired. From a breeding standpoint, however, where the production of hybrids is desired, the growing of plants from seed would be an advantage. It is likely, also, that definite strains or varieties of seed-bearing plants could be obtained by selection from plants that were grown from seed. In the ornamental field this would be desirable as the rosette type of plant is required by the ornamental trade.

# SANSEVIERIA REPRODUCTION FROM SEED

It is generally known that most species of sansevieria produce but few seeds or none at all. A review of the literature on sansevieria furnishes but little information regarding the production of seed by this plant. Augusto Perez Toro(1) states that sansevieria may be reproduced from seed but that the plants grow slowly and are unsatisfactory for fiber. No details are given. Ricardo Loret De Mola(2) mentions that sansevieria can be grown from seed but gives no details. The lack of information on this subject indicated the advisability of initiating a series of experiments in growing sansevieria from seed, for the purpose of obtaining additional information concerning the growth habits of the different species now being grown experimentally in the United States for the production of fiber.

---

1. Augusto Perez Toro. El Cultivo de la Sansevieria in Yucatan. p. 16. 1942.

2. Ricardo Loret De Mola.

It was apparent that more complete data on this subject would be useful not only in connection with the utilization of these plants for the production of fiber, but also from a horticultural viewpoint. Relatively large quantities of certain species of sansevieria are now grown by horticulturists for use as ornamental household plants. There is a large demand for these plants, and any new facts relating to the growth habits of the species used as ornamentals would be useful in this field. The experiments in growing sansevieria plants from seed were undertaken as a part of a sansevieria investigational project started in 1943, and conducted by the United States Department of Agriculture and cooperating agencies near Boynton, Florida. This paper covers only preliminary results obtained in experiments that are still in progress.

The principal species now being grown for fiber in the experimental work near Boynton is _Sansevieria_ _metallica_. Though indigenous to Africa, this species now occurs in patches of wild or semi-wild plants throughout South Florida on both the east and west coasts. It may also be found in many door-yards where it is grown as an ornamental plant. It does not produce any seed under Florida conditions. It is not known if seed is produced by this species in its native habitat in Africa. The flowers of some plants produce abundant pollen, but in most flowers the pistil has been reduced to a pistillode which remains sterile. A few _linocarps_ have been found on several wild plants indicating that development of the seed had begun but was not completed.

In contrast to *S. metallica*, the two principal ornamental species *S. zeylanica* and *S. lorentii* both produce seed though *lorentii* has been found with seed in only one locality in Miami, Florida. Seed production is rare, however, even with the ornamental species. The Florida growers of sansevieria plants that are to be used for ornamental purposes obtain their new stocks by asexual methods of propagation, and are not familiar with seed production.

Seeds have been found on *A. zeylanica* in Miami, Arcadia and Sebring, indicating that this species seeds more freely than *A. lorentii*, though the latter grows as freely and vigorously in these places as does *zeylanica*. One other species, not yet definitely identified, but probably *S. longiflora* or *S. rotundaflora*, at Sebring, Florida, also produces seed. The seeds of this species were not ripe when the plants were last inspected on August 20, 1944. One plant of *A. zeylanica* in the experimental plots produced fruit in September, 1944, but the fruits have not yet reached maturity (fig. ?).

In June, 1943, 25 seeds were obtained from plants of *S. zeylanica* in Arcadia, Florida. These seeds had been ripe for some time and 15 were partly shriveled. These 25 seeds were planted on June 19, and 6 of them germinated during the last week of July. No further germination was obtained with this lot of seed, probably due either to imperfect fertilization or to the fact that the seed had dried out sufficiently to kill the embryo.

Two other lots of seed that had been received from the American Consulate, Nairobi, Kenya, Africa, were also planted on June 19. The first lot, under P. I. number 146175, contained 32 seeds. On July 8, six of these seeds had germinated, and on July 31, fourteen plants were above ground. At this time these plants were sufficiently large for transplanting from the seed bed to pots. No further germination was obtained from this lot of seed. The second lot, under P. I. number 146174, contained 10 seeds. On July 8, six of these seeds had germinated. No further germination was obtained from this lot. The species of sansevieria from which these two lots of seed were obtained is not known. Photographs made of these plants on September 18, 1943, indicate that the seeds in these two lots were obtained from the same species. There are, however, marked differences between the African plants and those of _S. zeylanica_, which are shown by the leaves of the seedlings even in the very early stages of development. _S. zeylanica_ has a narrow leaf with a sharp pointed tip, whereas the African species has a broad leaf with a distinct marginal border, and with the apex much less pointed than in _zeylanica_. Another contrasting feature of the two species is the finely mottled upper surface of leaves of the African type, whereas the leaves of _zeylanica_ have a smooth upper surface entirely without spots.

A second lot of seed of _S. zeylanica_ and _S. lorentii_ was obtained in Miami, Florida, on July 15, 1944. Fifty seeds of _S. zeylanica_ and 6 seeds of _S. lorentii_ were planted on July 17, 1944. On August 5, forty-five seeds of _S. zeylanica_ and 4 of _S. lorentii_ had germinated. All of these seeds were freshly ripe when gathered and doubtless this factor contributed to the high percentage of germination.

## LENGTH OF TIME REQUIRED FOR GERMINATION

About six weeks was required for the germination of the seeds of S. zeylanica obtained from Arcadia. Six seeds of one lot of the African species germinated in three weeks, and six weeks after planting 14 plants of this group were sufficiently large for transplanting from the seed bed to pots. Six plants of the second lot of African seed had emerged in less than three weeks after planting, indicating a much shorter germinating period for the African seed as compared with that of the S. zeylanica, from Arcadia. However, the Miami lot of seed of S. zeylanica compared favorably with the African seed in length of time required for germination.

## DEVELOPMENT OF SEEDLINGS

Seedlings from the first lot of Arcadia seed were potted in 2-inch pots when 30 days old and placed outdoors in a half-shade. The plants grew rapidly for a few weeks until the first six or eight leaves had formed, and then they grew very slowly for a period of nearly eight months. This slow growth doubtless was prolonged by the rather cold nights of the winter months, and the fact that the plants remained in small pots. At the end of one year these plants were still small with only six to ten leaves, typically rosette in form. In July, 1944, the plants were transferred to 4-inch pots and rapid growth began. The characteristic color of the "character" leaf was distinctly visible in the S. zeylanica by September, and the leaves began to assume a more upright position indicating the beginning of the formation of petioles that are a part of the "character" leaf. By this time a large mass of fibrous roots had been formed on the plants.

## PREPARATION OF SEED BED

The seed bed consisted of light sand mixed with one part muck. This soil mixture was placed in a flat to a depth of four inches when firmly pressed down. The seeds were planted one inch apart in check rows and were pressed into the soil and very lightly covered with soil firmly pressed down. Before planting, the seeds were cleaned of all pulp by washing in warm water. The seed flat was kept in a half-shade and the soil was kept moist at all times, but not soggy, until germination of the seeds was complete.

## JUVENILE ROOT SYSTEM

When germination begins, two roots resembling small tap roots emerge almost directly from the seed. These roots grow about two inches long and are a typical orange-red color. At this stage of growth most of the plant's nourishment is still supplied by the slowly digesting seed. After the shoots appear above ground a few additional roots are formed, but several weeks elapse before the fine lateral roots begin to branch out from the minature tap roots. During this period the plants grow slowly. As more lateral roots develop, rapidity of growth increases and when a large mass of fibrous roots has been formed the plants begin to grow very fast. During the stage when the mass of fibrous roots is being formed, there is no sign of the appearance of rhizomes. When leaf cuttings are rooted, no long vertical roots are formed, but only short white roots that are soon followed by branching lateral roots. The fibrous roots thus formed are soon followed by the formation of rhi,omes which, in turn, produce a new shoot above ground. The fundamental difference between seed-produced plants and plants produced from leaf cuttings is that seedling plants produce no rhizomes before "character" leaves are formed.

## DESCRIPTION OF FRUIT AND SEED

The green fruits of S. zeylanica are about one-fourth inch in diameter. At maturity the seed is covered with a very thin fleshy pulp. In Arcadia, Florida, the plants bloom in January and February and the fruits ripen in late June and early July. Once the fruits begin to ripen only a few days elapse before they are completely ripe. When fully ripe the fruits are a bright orange-red color, and usually remain on the plant for only a few days before dropping. A normally matured fruit contains three cells with each cell containing one seed, but most of the fruits that have been found were either single or double-celled. After the fruit is ripe the thin soft pulp separates readily from the seed which is white in color, hard, and slightly oval in shape. Like many of the palm seeds, the seeds of sansevieria are composed largely of albumen and a slow germination would, therefore, be expected. The surface is smooth and the embryo is readily visible to the naked eye as a minute dark-colored spot, sometimes slightly elevated above the surface of the seed and very shallow. This indicates that the seed would be very perishable if allowed to dry out for any appreciable length of time. The poor germination of the sansevieria seed received from Africa may have been partly due to excessive drying out during transit.

## JUVENILE LEAVES

As indicated elsewhere, germination takes place rather rapidly. The first two or three leaves appear above ground as bladeless sheaths followed in turn by succeeding leaves, very minute at first, but each leaf slightly larger than the one preceding, until the juvenile leaves reach full size. At emergence, the leaves are almost vertical but as they grow older they spread out and assume a more horizontal position, giving the plant the characteristic "rosette" form. This rosette form is a definitely juvenile character and the plants remain in this stage for many months before upright leaves are formed, even though the character leaf may be distinguished in the rosette stage. Another feature of juvenile leaves is that they have no petiole as do the adult upright leaves. The length of the juvenile period will vary under different conditions of growth, but at least two years will probably be required before upright leaves with full petioles are formed. It is likely that true upright leaves will not form until rhizomes are produced. Since only upright leaves are suitable for fiber, this characteristic feature of young seedling plants having only rosette leaves renders the use of seed undesirable as a propagating material where an early upright leaf is desired. From a breeding standpoint, however, where the production of hybrids is desired, the growing of plants from seed would be an advantage. It is likely, also, that definite strains or varieties of seed-bearing plants could be obtained by selection from plants that were grown from seed. In the ornamental field this would be desirable as the rosette type of plant is required by the ornamental trade.

# SANSEVIERIA REPRODUCTION FROM SEED

It is generally known that most species of sansevieria produce but few seeds or none at all. A review of the literature on sansevieria furnishes but little information regarding the production of seed by this plant. Augusto Perez Toro(1) states that sansevieria may be reproduced from seed but that the plants grow slowly and are unsatisfactory for fiber. No details are given. Ricardo Loret De Mola(2) mentions that sansevieria can be grown from seed but gives no details. The lack of information on this subject indicated the advisability of initiating a series of experiments in growing sansevieria from seed, for the purpose of obtaining additional information concerning the growth habits of the different species now being grown experimentally in the United States for the production of fiber.

---

1. Augusto Perez Toro. El Cultivo de la Sansevieria in Yucatan. p. 16. 1942.

2. Ricardo Loret De Mola.

It was apparent that more complete data on this subject would be useful not only in connection with the utilization of these plants for the production of fiber, but also from a horticultural viewpoint. Relatively large quantities of certain species of sansevieria are now grown by horticulturists for use as ornamental household plants. There is a large demand for these plants, and any new facts relating to the growth habits of the species used as ornamentals would be useful in this field. The experiments in growing sansevieria plants from seed were undertaken as a part of a sansevieria investigational project started in 1943, and conducted by the United States Department of Agriculture and cooperating agencies near Boynton, Florida. This paper covers only preliminary results obtained in experiments that are still in progress.

The principal species now being grown for fiber in the experimental work near Boynton is _Sansevieria metallica_. Though indigenous to Africa, this species now occurs in patches of wild or semi-wild plants throughout South Florida on both the east and west coasts. It may also be found in many door-yards where it is grown as an ornamental plant. It does not produce any seed under Florida conditions. It is not known if seed is produced by this species in its native habitat in Africa. The flowers of some plants produce abundant pollen, but in most flowers the pistil has been reduced to a pistillode which remains sterile. A few _linocarps_ have been found on several wild plants indicating that development of the seed had begun but was not completed.

In contrast to *S. metallica*, the two principal ornamental species *S. zeylanica* and *S. lorentii* both produce seed though *lorentii* has been found with seed in only one locality in Miami, Florida. Seed production is rare, however, even with the ornamental species. The Florida growers of sansevieria plants that are to be used for ornamental purposes obtain their new stocks by asexual methods of propagation, and are not familiar with seed production.

Seeds have been found on *A. zeylanica* in Miami, Arcadia and Sebring, indicating that this species seeds more freely than *A. lorentii*, though the latter grows as freely and vigorously in these places as does *zeylanica*. One other species, not yet definitely identified, but probably *S. longiflora* or *S. rotundaflora*, at Sebring, Florida, also produces seed. The seeds of this species were not ripe when the plants were last inspected on August 20, 1944. One plant of *A. zeylanica* in the experimental plots produced fruit in September, 1944, but the fruits have not yet reached maturity (fig. ?).

In June, 1943, 25 seeds were obtained from plants of *S. zeylanica* in Arcadia, Florida. These seeds had been ripe for some time and 15 were partly shriveled. These 25 seeds were planted on June 19, and 6 of them germinated during the last week of July. No further germination was obtained with this lot of seed, probably due either to imperfect fertilization or to the fact that the seed had dried out sufficiently to kill the embryo.

Two other lots of seed that had been received from the American Consulate, Nairobi, Kenya, Africa, were also planted on June 19. The first lot, under P. I. number 146175, contained 32 seeds. On July 8, six of these seeds had germinated, and on July 31, fourteen plants were above ground. At this time these plants were sufficiently large for transplanting from the seed bed to pots. No further germination was obtained from this lot of seed. The second lot, under P. I. number 146174, contained 10 seeds. On July 8, six of these seeds had germinated. No further germination was obtained from this lot. The species of sansevieria from which these two lots of seed were obtained is not known. Photographs made of these plants on September 18, 1943, indicate that the seeds in these two lots were obtained from the same species. There are, however, marked differences between the African plants and those of S. zeylanica, which are shown by the leaves of the seedlings even in the very early stages of development. S. zeylanica has a narrow leaf with a sharp pointed tip, whereas the African species has a broad leaf with a distinct marginal border, and with the apex much less pointed than in zeylanica. Another contrasting feature of the two species is the finely mottled upper surface of leaves of the African type, whereas the leaves of zeylanica have a smooth upper surface entirely without spots.

A second lot of seed of S. zeylanica and S. lorentii was obtained in Miami, Florida, on July 15, 1944. Fifty seeds of S. zeylanica and 6 seeds of S. lorentii were planted on July 17, 1944. On August 5, forty-five seeds of S. zeylanica and 4 of S. lorentii had germinated. All of these seeds were freshly ripe when gathered and doubtless this factor contributed to the high percentage of germination.

## LENGTH OF TIME REQUIRED FOR GERMINATION

About six weeks was required for the germination of the seeds of S. zeylanica obtained from Arcadia. Six seeds of one lot of the African species germinated in three weeks, and six weeks after planting 14 plants of this group were sufficiently large for transplanting from the seed bed to pots. Six plants of the second lot of African seed had emerged in less than three weeks after planting, indicating a much shorter germinating period for the African seed as compared with that of the S. zeylanica, from Arcadia. However, the Miami lot of seed of S. zeylanica compared favorably with the African seed in length of time required for germination.

## DEVELOPMENT OF SEEDLINGS

Seedlings from the first lot of Arcadia seed were potted in 2-inch pots when 30 days old and placed outdoors in a half-shade. The plants grew rapidly for a few weeks until the first six or eight leaves had formed, and then they grew very slowly for a period of nearly eight months. This slow growth doubtless was prolonged by the rather cold nights of the winter months, and the fact that the plants remained in small pots. At the end of one year these plants were still small with only six to ten leaves, typically rosette in form. In July, 1944, the plants were transferred to 4-inch pots and rapid growth began. The characteristic color of the "character" leaf was distinctly visible in the S. zeylanica by September, and the leaves began to assume a more upright position indicating the beginning of the formation of petioles that are a part of the "character" leaf. By this time a large mass of fibrous roots had been formed on the plants.

## PREPARATION OF SEED BED

The seed bed consisted of light sand mixed with one part muck. This soil mixture was placed in a flat to a depth of four inches when firmly pressed down. The seeds were planted one inch apart in check rows and were pressed into the soil and very lightly covered with soil firmly pressed down. Before planting, the seeds were cleaned of all pulp by washing in warm water. The seed flat was kept in a half-shade and the soil was kept moist at all times, but not soggy, until germination of the seeds was complete.

## JUVENILE ROOT SYSTEM

When germination begins, two roots resembling small tap roots emerge almost directly from the seed. These roots grow about two inches long and are a typical orange-red color. At this stage of growth most of the plant's nourishment is still supplied by the slowly digesting seed. After the shoots appear above ground a few additional roots are formed, but several weeks elapse before the fine lateral roots begin to branch out from the minature tap roots. During this period the plants grow slowly. As more lateral roots develop, rapidity of growth increases and when a large mass of fibrous roots has been formed the plants begin to grow very fast. During the stage when the mass of fibrous roots is being formed, there is no sign of the appearance of rhizomes. When leaf cuttings are rooted, no long vertical roots are formed, but only short white roots that are soon followed by branching lateral roots. The fibrous roots thus formed are soon followed by the formation of rhi,omes which, in turn, produce a new shoot above ground. The fundamental difference between seed-produced plants and plants produced from leaf cuttings is that seedling plants produce no rhizomes before "character" leaves are formed.

## DESCRIPTION OF FRUIT AND SEED

The green fruits of S. zeylanica are about one-fourth inch in diameter. At maturity the seed is covered with a very thin fleshy pulp. In Arcadia, Florida, the plants bloom in January and February and the fruits ripen in late June and early July. Once the fruits begin to ripen only a few days elapse before they are completely ripe. When fully ripe the fruits are a bright orange-red color, and usually remain on the plant for only a few days before dropping. A normally matured fruit contains three cells with each cell containing one seed, but most of the fruits that have been found were either single or double-celled. After the fruit is ripe the thin soft pulp separates readily from the seed which is white in color, hard, and slightly oval in shape. Like many of the palm seeds, the seeds of sansevieria are composed largely of albumen and a slow germination would, therefore, be expected. The surface is smooth and the embryo is readily visible to the naked eye as a minute dark-colored spot, sometimes slightly elevated above the surface of the seed and very shallow. This indicates that the seed would be very perishable if allowed to dry out for any appreciable length of time. The poor germination of the sansevieria seed received from Africa may have been partly due to excessive drying out during transit.

## JUVENILE LEAVES

As indicated elsewhere, germination takes place rather rapidly. The first two or three leaves appear above ground as bladeless sheaths followed in turn by succeeding leaves, very minute at first, but each leaf slightly larger than the one preceding, until the juvenile leaves reach full size. At emergence, the leaves are almost vertical but as they grow older they spread out and assume a more horizontal position, giving the plant the characteristic "rosette" form. This rosette form is a definitely juvenile character and the plants remain in this stage for many months before upright leaves are formed, even though the character leaf may be distinguished in the rosette stage. Another feature of juvenile leaves is that they have no petiole as do the adult upright leaves. The length of the juvenile period will vary under different conditions of growth, but at least two years will probably be required before upright leaves with full petioles are formed. It is likely that true upright leaves will not form until rhizomes are produced. Since only upright leaves are suitable for fiber, this characteristic feature of young seedling plants having only rosette leaves renders the use of seed undesirable as a propagating material where an early upright leaf is desired. From a breeding standpoint, however, where the production of hybrids is desired, the growing of plants from seed would be an advantage. It is likely, also, that definite strains or varieties of seed-bearing plants could be obtained by selection from plants that were grown from seed. In the ornamental field this would be desirable as the rosette type of plant is required by the ornamental trade.

# SANSEVIERIA REPRODUCTION FROM RHIZOMES

One of the most commonly used methods of propagating sansevieria is the planting of the underground rootstocks, or rhizomes. As ornamental planting stock, rhizomes have a distinct advantage over leaf cuttings in that they come "true", that is, all of the plant characters of the parent stock are transmitted as they are in seed. Leaf cuttings do not possess this power of character transmittal, since some of the plant characters are not carried in the somatic bud tissue.

## METHODS OF PLANTING RHIZOMES

In the field plantings of sansevieria for fiber investigations, approximately two acres were planted with rhizomes. As no information regarding the use of rhizomes as propagating material was available, several different methods of planting were used. In one test the rhizomes were cut into sections 3" and 5" in length and were planted in rows 18" wide and 350 feet long. The sections were spaced one inch apart in the drill. In another test the rhizomes were not cut into any definite lengths, but were planted in the drill just as they were dug from the ground. Instead of leaving a space between the sections, they were planted with the ends touching each other in the drill. Row width and length were the same as for the 3" and 5" sections. In both tests there were 21 rows in each block.

These two tests constituted the main rhizome plantings but two smaller plantings which will be referred to subsequently in this paper, were made for testing other factors.

All planting was done by hand, half-bushel baskets being used to hold the rhizomes when they were unloaded in the field. A special type of machine was used to open the furrows, 5 rows being opened in a single operation. The rhizomes were covered 2" deep. All plantings were made during the last week in March, 1943. The type of soil on which the plantings were made is a Leon Fine Sandy Loam. Because of the extremely dry weather in the spring and early summer of 1943, very few plants came up until several weeks after the summer rains had started in late June. Standard 4-7-5 fertilizer was applied every three months at the rate of 600 pounds per acre, one-third of this amount being used at each application.

A plant count made on December 15, 1943, showed that the 3" and 5" rhizome blocks had 5800 plants per block, while the rhizomes planted solidly had 6000 plants per block. A second check made on November 15, 1944, showed that the rhizome beds planted solidly had approximately twice as many plants per bed as the 3" and 5" beds. At no time have the plants multiplied as rapidly as they do from whole plants, cut-back plants or leaf cuttings.

## A SPECIAL CHARACTER OF RHIZOMES

Although a fairly satisfactory stand of plants was eventually obtained from the rhizome plantings, the plants were not suitable for fiber purposes since all of the first plants that come directly from the rhizomes are rosette in form; that is, the leaves are short and spread out horizontally instead of growing upright or vertically. The second plant which arises from a rhizome produced by the first plant is usually an intermediate plant in height; that is, it is neither a true rosette nor a true upright plant. However, the third plant which is produced from the second plant is a true upright and produces leaves suitable for fiber purposes.

Thus, rhizomes, like seed require a rather long period before fully upright plants are produced, probably two years or longer. Also, like seed, rhizomes presumably carry all of the plant characters of the parent stock. They first produce rosette leaves which is a typically juvenile character. Unlike the leaves produced by seedlings, the first leaves produced by rhizomes have all of the colors of the upright character leaf of the parent stock. The first leaves of plants produced from seed do not show true "character", but "character" leaves are gradually acquired. This is one of the fundamental differences between plants produced from seed and plants produced from rhizomes.

## ROOTS FORMED BY RHIZOMES

Unlike leaf cuttings or seeds, rhizomes do not put out any small roots, but a new primary rhizome develops directly from the old rhizome. From this primary rhizome new lateral roots emerge as soon as the shoot is above the surface of the ground.

## SANSEVIERIA REPRODUCTION FROM RHIZOMES

One of the most commonly used methods of propagating sansevieria is the planting of the underground rootstocks, or rhizomes. As ornamental planting stock, rhizomes have a distinct advantage over leaf cuttings in that they come "true", that is, all of the plant characters of the parent stock are transmitted as they are in seed. Leaf cuttings do not possess this power of character transmittal, since some of the plant characters are not carried in the somatic bud tissue.

## METHODS OF PLANTING RHIZOMES

In the field plantings of sansevieria for fiber investigations, approximately two acres were planted with rhizomes. As no information regarding the use of rhizomes as propagating material was available, several different methods of planting were used. In one test the rhizomes were cut into sections 3" and 5" in length and were planted in rows 18" wide and 350 feet long. The sections were spaced one inch apart in the drill. In another test the rhizomes were not cut into any definite lengths, but were planted in the drill just as they were dug from the ground. Instead of leaving a space between the sections, they were planted with the ends touching each other in the drill. Row width and length were the same as for the 3" and 5" sections. In both tests there were 21 rows in each block.

These two tests constituted the main rhizome plantings but two smaller plantings which will be referred to subsequently in this paper, were made for testing other factors.

All planting was done by hand, half-bushel baskets being used to hold the rhizomes when they were unloaded in the field. A special type of machine was used to open the furrows, 5 rows being opened in a single operation. The rhizomes were covered 2" deep. All plantings were made during the last week in March, 1943. The type of soil on which the plantings were made is a Leon Fine Sandy Loam. Because of the extremely dry weather in the spring and early summer of 1943, very few plants came up until several weeks after the summer rains had started in late June. Standard 4-7-5 fertilizer was applied every three months at the rate of 600 pounds per acre, one-third of this amount being used at each application.

A plant count made on December 15, 1943, showed that the 3" and 5" rhizome blocks had 5800 plants per block, while the rhizomes planted solidly had 8000 plants per block. A second check made on November 15, 1944, showed that the rhizome beds planted solidly had approximately twice as many plants per bed as the 3" and 5" beds. At no time have the plants multiplied as rapidly as they do from whole plants, cut-back plants or leaf cuttings.

## A SPECIAL CHARACTER OF RHIZOMES

Although a fairly satisfactory stand of plants was eventually obtained from the rhizome plantings, the plants were not suitable for fiber purposes since all of the first plants that come directly from the rhizomes are rosette in form; that is, the leaves are short and spread out horizontally instead of growing upright or vertically. The second plant which arises from a rhizome produced by the first plant is usually an intermediate plant in height; that is, it is neither a true rosette nor a true upright plant. However, the third plant which is produced from the second plant is a true upright and produces leaves suitable for fiber purposes.

Thus, rhizomes, like seed require a rather long period before fully upright plants are produced, probably two years or longer. Also, like seed, rhizomes presumably carry all of the plant characters of the parent stock. They first produce rosette leaves which is a typically juvenile character. Unlike the leaves produced by seedlings, the first leaves produced by rhizomes have all of the colors of the upright character leaf of the parent stock. The first leaves of plants produced from seed do not show true "character", but "character" leaves are gradually acquired. This is one of the fundamental differences between plants produced from seed and plants produced from rhizomes.

## ROOTS FORMED BY RHIZOMES

Unlike leaf cuttings or seeds, rhizomes do not put out any small roots, but a new primary rhizome develops directly from the old rhizome. From this primary rhizome new lateral roots emerge as soon as the shoot is above the surface of the ground.

# SANSEVIERIA REPRODUCTION FROM RHIZOMES

One of the most commonly used methods of propagating sansevieria is the planting of the underground rootstocks, or rhizomes. As ornamental planting stock, rhizomes have a distinct advantage over leaf cuttings in that they come "true", that is, all of the plant characters of the parent stock are transmitted as they are in seed. Leaf cuttings do not possess this power of character transmittal, since some of the plant characters are not carried in the somatic bud tissue.

## METHODS OF PLANTING RHIZOMES

In the field plantings of sansevieria for fiber investigations, approximately two acres were planted with rhizomes. As no information regarding the use of rhizomes as propagating material was available, several different methods of planting were used. In one test the rhizomes were cut into sections 3" and 5" in length and were planted in rows 18" wide and 350 feet long. The sections were spaced one inch apart in the drill. In another test the rhizomes were not cut into any definite lengths, but were planted in the drill just as they were dug from the ground. Instead of leaving a space between the sections, they were planted with the ends touching each other in the drill. Row width and length were the same as for the 3" and 5" sections. In both tests there were 21 rows in each block.

These two tests constituted the main rhizome plantings but two smaller plantings which will be referred to subsequently in this paper, were made for testing other factors.

All planting was done by hand, half-bushel baskets being used to hold the rhizomes when they were unloaded in the field. A special type of machine was used to open the furrows, 5 rows being opened in a single operation. The rhizomes were covered 2" deep. All plantings were made during the last week in March, 1943. The type of soil on which the plantings were made is a Leon Fine Sandy Loam. Because of the extremely dry weather in the spring and early summer of 1943, very few plants came up until several weeks after the summer rains had started in late June. Standard 4-7-5 fertilizer was applied every three months at the rate of 600 pounds per acre, one-third of this amount being used at each application.

A plant count made on December 15, 1943, showed that the 3" and 5" rhizome blocks had 5800 plants per block, while the rhizomes planted solidly had 6000 plants per block. A second check made on November 15, 1944, showed that the rhizome beds planted solidly had approximately twice as many plants per bed as the 3" and 5" beds. At no time have the plants multiplied as rapidly as they do from whole plants, cut-back plants or leaf cuttings.

## A SPECIAL CHARACTER OF RHIZOMES

Although a fairly satisfactory stand of plants was eventually obtained from the rhizome plantings, the plants were not suitable for fiber purposes since all of the first plants that come directly from the rhizomes are rosette in form; that is, the leaves are short and spread out horizontally instead of growing upright or vertically. The second plant which arises from a rhizome produced by the first plant is usually an intermediate plant in height; that is, it is neither a true rosette nor a true upright plant. However, the third plant which is produced from the second plant is a true upright and produces leaves suitable for fiber purposes.

Thus, rhizomes, like seed require a rather long period before fully upright plants are produced, probably two years or longer. Also, like seed, rhizomes presumably carry all of the plant characters of the parent stock. They first produce rosette leaves which is a typically juvenile character. Unlike the leaves produced by seedlings, the first leaves produced by rhizomes have all of the colors of the upright character leaf of the parent stock. The first leaves of plants produced from seed do not show true "character", but "character" leaves are gradually acquired. This is one of the fundamental differences between plants produced from seed and plants produced from rhizomes.

## ROOTS FORMED BY RHIZOMES

Unlike leaf cuttings or seeds, rhizomes do not put out any small roots, but a new primary rhizome develops directly from the old rhizome. From this primary rhizome new lateral roots emerge as soon as the shoot is above the surface of the ground.

## SANSEVIERIA REPRODUCTION FROM RHIZOMES

One of the most commonly used methods of propagating sansevieria is the planting of the underground rootstocks, or rhizomes. As ornamental planting stock, rhizomes have a distinct advantage over leaf cuttings in that they come "true", that is, all of the plant characters of the parent stock are transmitted as they are in seed. Leaf cuttings do not possess this power of character transmittal, since some of the plant characters are not carried in the somatic bud tissue.

### METHODS OF PLANTING RHIZOMES

In the field plantings of sansevieria for fiber investigations, approximately two acres were planted with rhizomes. As no information regarding the use of rhizomes as propagating material was available, several different methods of planting were used. In one test the rhizomes were cut into sections 3" and 5" in length and were planted in rows 18" wide and 350 feet long. The sections were spaced one inch apart in the drill. In another test the rhizomes were not cut into any definite lengths, but were planted in the drill just as they were dug from the ground. Instead of leaving a space between the sections, they were planted with the ends touching each other in the drill. Row width and length were the same as for the 3" and 5" sections. In both tests there were 21 rows in each block.

These two tests constituted the main rhizome plantings but two smaller plantings which will be referred to subsequently in this paper, were made for testing other factors.

All planting was done by hand, half-bushel baskets being used to hold the rhizomes when they were unloaded in the field. A special type of machine was used to open the furrows, 5 rows being opened in a single operation. The rhizomes were covered 2" deep. All plantings were made during the last week in March, 1943. The type of soil on which the plantings were made is a Leon Fine Sandy Loam. Because of the extremely dry weather in the spring and early summer of 1943, very few plants came up until several weeks after the summer rains had started in late June. Standard 4-7-5 fertilizer was applied every three months at the rate of 600 pounds per acre, one-third of this amount being used at each application.

A plant count made on December 15, 1943, showed that the 3" and 5" rhizome blocks had 5800 plants per block, while the rhizomes planted solidly had 8000 plants per block. A second check made on November 15, 1944, showed that the rhizome beds planted solidly had approximately twice as many plants per bed as the 3" and 5" beds. At no time have the plants multiplied as rapidly as they do from whole plants, cut-back plants or leaf cuttings.

## A SPECIAL CHARACTER OF RHIZOMES

Although a fairly satisfactory stand of plants was eventually obtained from the rhizome plantings, the plants were not suitable for fiber purposes since all of the first plants that come directly from the rhizomes are rosette in form; that is, the leaves are short and spread out horizontally instead of growing upright or vertically. The second plant which arises from a rhizome produced by the first plant is usually an intermediate plant in height; that is, it is neither a true rosette nor a true upright plant. However, the third plant which is produced from the second plant is a true upright and produces leaves suitable for fiber purposes.

Thus, rhizomes, like seed require a rather long period before fully upright plants are produced, probably two years or longer. Also, like seed, rhizomes presumably carry all of the plant characters of the parent stock. They first produce rosette leaves which is a typically juvenile character. Unlike the leaves produced by seedlings, the first leaves produced by rhizomes have all of the colors of the upright character leaf of the parent stock. The first leaves of plants produced from seed do not show true "character", but "character" leaves are gradually acquired. This is one of the fundamental differences between plants produced from seed and plants produced from rhizomes.

## ROOTS FORMED BY RHIZOMES

Unlike leaf cuttings or seeds, rhizomes do not put out any small roots, but a new primary rhizome develops directly from the old rhizome. From this primary rhizome new lateral roots emerge as soon as the shoot is above the surface of the ground.

# SANSEVIERIA REPRODUCTION FROM LEAF CUTTINGS

Experiments were initiated in the early summer of 1943 for the purpose of determining the feasibility of using leaf cuttings of sansevieria as a source of planting stock for possible commercial plantings. Plantings were made each month, beginning in July, to test the possible effects of different dates of planting, and different parts of the leaf were used as planting stock. The parts of the leaf used were the base of the petiole, sections from the middle of the leaf blade and the tip end of the leaf. This paper deals with the results obtained during the first 14 months of these experiments.

## Plan of Experiments

Each experiment included from 20 to 100 sections of each type of planting stock, and plantings were made on the 25th day of each month. The sections were planted 4 inches deep in a very light sandy soil in rows 6 feet wide, and were spaced 2 inches apart in the drill. All planting stock used consisted of leaves of wild plants, all of which were obtained from the same source. The sections were cut 12 inches in length and only whole cross sections of the plant were used; that is, the leaf or petiole was not split vertically in this series of experiments. In an earlier experiment, which will be discussed briefly in this paper, two rows of leaf cuttings, in which the sections were split vertically, were planted. Fresh planting stock was always used, each planting being made within two or three hours after the material had been cut. None of the plantings were watered at any time.

[illegible]

[illegible]

Time of Experiments

[illegible]

The tabulated results of the 14 monthly plantings are shown in table 1. In general it has been found that the best results are obtained with the tip sections, followed in turn by the middle sections of the leaf and by the petiole sections last. The petiole sections not only germinate the least satisfactorily but each section usually produces only one plant, whereas, the middle and tip sections both produce several plants from each section. The number of sections of each type of material planted during this period was 712 base, 570 middle and 430 tip. The number of each type that died was 246 base, 85 middle and 99 tip sections, leaving 466 base sections, 485 middle and 331 tip alive on September 1, 1944. For the first nine months only 107 plants had been produced by the 466 base sections, compared with 449 plants produced by the 485 middle sections and 650 plants by the 331 tip sections. Thus, for the first nine months the base sections averaged less than one plant per four sections, whereas, the middle sections averaged almost one plant per section and the tips almost two plants per section. The tip section has consistently given the best results. Not only does the tip section produce more plants, but also it roots the most rapidly and the plants grow more rapidly than those produced by the middle and basal sections. In some cases, sections of all three types were still alive on September 1, 1944, but had not produced any plants above ground. It is possible, therefore, that the number of plants ultimately obtained from each type of material may vary somewhat from the present records of production. It appears unlikely, however, that the basal sections will ever approach the averages of the middle and tip sections.

## LENGTH OF TIME REQUIRED TO PRODUCE ROOTS, RHIZOMES AND PLANTS

Tips: Under favorable conditions tip sections will produce roots in 20 days and rhizomes in 70 to 90 days. Also under favorable conditions, from 90 to 120 days will elapse before new plants appear above ground from rooted cuttings. During the dry winter and spring months, as shown in table 1, this period may be as long as five months. From January until July, 1944, was an extremely dry period and no plants appeared above ground from any of the monthly plantings made after March of this period, although adventitious roots formed on many sections of cuttings planted in April, May, June and July. It is believed that insufficient moisture prevented the formation of rhizomes from which the new plants are formed.

Middle Sections: The results obtained with middle sections of the leaf are in general similar to the results obtained with the tips, except that adventitious roots form a little more slowly than with the tip sections. Also, rhizomes are formed a little more slowly, and the number of rhizomes produced by a section of given size are less than with a tip section of the same size. Plate No.      shows two middle sections, one 25 days old and one 50 days old. A notable feature of the roots on the 25-day-old section is that they are simple straight roots, not branched and white in color. These function in a manner similar to tap roots and may be regarded as modified tap roots. The roots on the 50-day-old section are branched and have the typical orange-red color. All of the roots in both sections arise deep in the tissues of the leaf rather than on the surface, though the mass of red branched roots is closer to the surface than are the white unbranched roots. The 50-day-old section shows no signs of forming rhizomes even though the mass of fibrous roots is large.

Once the tip and middle sections begin to form roots, the portion above ground acts as a new plant, furnishing a supply of plant food to the root system which rapidly expands until a mass of roots is formed. These sections remain green even after many new plants have been produced above ground, showing that the leaf is still active in the manufacture of plant food.

Base Sections: Base sections of the petiole require 60 to 90 days before adventitious roots appear, and even then only a few roots are formed. The lack of adventitious buds in the petiole section prevents the formation of many roots. Even after the roots are formed they usually remain small, which is probably due to the lack of chlorophyll in the petiole section. This would naturally result in less plant food with which to build a vigorous root system.

## SYSTEM OF ROOT DEVELOPMENT

In the development of new plants from leaf cuttings, three distinct growth periods or phases may be recognized. The first covers the formation of the scattered, unbranched adventitious roots, while the second signalizes the formation of a mass of branched roots characteristically red in color. Following these two periods is the formation of rhizomes and the appearance above ground of the new plant.

Like the adventitious roots, the rhizomes arise from inner bud tissue at the very base of the cut section, though just how the rhizome buds are differentiated from the other buds which form masses of fibrous roots is a physiological factor not yet clearly understood. Also, the fact that when rhizomes are planted, new rhizomes are formed without the formation of any fibrous roots is an interesting physiological phenomenon not found in the rooting of leaf cuttings, where masses of fibrous roots always precede the formation of rhizomes.

Rhizomes from rooted leaf cuttings almost invariably grow horizontally for two or three inches from the leaf section and then assume a vertical position. They are also white in color when first formed like the first unbranched roots. Thus there are three stages of specialized root development; first, white unbranched roots, followed by masses of red roots and then by white rhizomes. No roots are formed on the rhizome until the shoot appears above ground. As soon as the shoot appears above the surface of the soil lateral roots with branches form rapidly along the rhigomes. The same stage of root development is repeated on the rhizome as in the leaf section, namely, white unbranched roots are formed first, followed by many branched red-colored roots. Eventually the entire rhizome turns orange-red.

## TYPE OF PLANTS PRODUCED BY LEAF CUTTINGS

Unlike seed and rhizomes, which produce plants of the rosette or partially upright type, all of the plants obtained from whole sections of leaf cuttings are upright in form. This habit of producing upright plants is a distinct advantage from a fiber standpoint since only leaves with long petioles are suitable for fiber. The elimination of the intermediate stages of passing from rosette to upright leaves greatly shortens the period of time required to mature leaves suitable for fiber purposes. Compared with rosette plants, this growth habit of leaf cuttings shortens the growing period from planting to maturity by as much as a year or longer when a fiber leaf is the primary consideration.

## LEAF CUTTINGS SPLIT VERTICALLY

In August, 1942, before the series of experiments discussed in this paper had been planned, a few leaf sections that had been split vertically into halves, thirds, fourths and eights were planted. Only middle and tip sections were used. All of these rooted readily, but the smaller sections produced only one plant each. Also, unlike the whole sections, the smaller sections produced only rosette plants which were very small and weak. All of these sections were transplanted from a field where they were first rooted to their present location adjoining the monthly experiments. Transplanting was done during dry weather and the plants were injured severely though but few died. The present vigorous condition of these plants is shown in Plate . The rosette plants obtained from the small split-leaf sections is the only instance noted where rosette plants have been produced from leaf cuttings.

## COMMERCIAL PLANTING OF LEAF CUTTINGS

Leaf cuttings were planted experimentally on a commercial scale in the spring of 1943, but most of these plants died, due primarily to the extremely dry weather and the small size of the leaf section which caused them to rapidly dry out and shrivel in the hot, dry sandy soil. Many of the leaf sections were split vertically into small sections, which subsequent investigations have shown was an error. Also, much of the stock used was several days old, rather than freshly cut material, a factor that is detrimental where leaf cuttings are used for planting stock.

An efficient leaf-cutting machine for preparing leaf sections on a commercial scale, which is driven by a 1/4 H.P. electric motor, was designed and built by Mr. Oscar, R. Winchester. This machine is so designed that each leaf section is cut with a fork in the end which goes into the ground. This was done in order that the sections might be planted without reversing their polarity; that is, to avoid turning the sections up side down. Except in rare cases, leaf cuttings planted with the ends reversed will not root. In the experimental work that has thus far been done, not a single leaf section with the ends reversed has rooted in the field.

This leaf-cutting machine is easily operated and a large quantity of planting material can be prepared in a relatively short period of time. The length of the leaf section is readily regulated by means of an adjustable backstop, which is shown in Plate . As the sections are cut they fall into a 2-bushel crate. When the required number of crates of planting material have been prepared they are taken to the field by truck. Planting is done by hand.

Although this particular experiment was not successful, this does not necessarily mean that the use of leaf cuttings as planting stock is impracticable. Information now available indicates that if the leaves are freshly cut, properly prepared, and planted under suitable temperature and moisture conditions, a satisfactory stand of plants is likely to be obtained. The advantages of leaf cuttings for planting stock are that they are cheap, easy to plant, and will produce a large number of plants of the right type for fiber. Also, a growth of plants sufficiently dense to crowd out the weeds is obtained, which is a very important item in getting a crop of sansevieria started.

| Date of Planting | Number and Kind of Leaf Sections Planted<br>Base-Middle-Tip | | | Number of Sections Dead on September 1, 1944<br>Base-Middle-Tip | | | Number of Plants Produced from all Sections of each Type of Cutting by Sept. 1, 1944<br>Base-Middle-Tip | | | Average Height in Inches of Plants Produced by each Type of Cutting - September 1, 1944<br>Base-Middle-Tip | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/25/43 | 60 | 50 | 50 | 25 | 10 | 30 | 22 | 75 | 50 | 6" | 10" | 12" |
| 8/25/43 | 70 | 70 | 70 | 2 | 2 | 2 | 33 | 96 | 215 | 8 | 12 | 15 |
| 9/25/43 | 100 | 100 | 100 | 43 | 25 | 25 | 24 | 65 | 152 | 8 | 8 | 12 |
| 10/25/43 | 125 | 100 | 50 | 34 | 18 | 5 | 16 | 105 | 90 | 6 | 12 | 12 |
| 11/25/43 | 150 | 75 | 40 | 96 | 18 | 24 | 5 | 50 | 32 | 4 | 6 | 6 |
| 12/25/43 | 32 | 20 | 15 | 25 | 2 | 3 | 1 | 12 | 15 | 3 | 4 | 6 |
| 1/25/44 | 50 | 30 | 20 | 5 | 3 | 2 | 2 | 25 | 25 | 2 | 5 | 6 |
| 2/25/44 | 50 | 75 | 50 | 8 | 4 | 3 | 1 | 17 | 30 | 3 | 3 | 4 |
| 3/25/44 | 75 | 50 | 35 | 8 | 2 | 5 | 3 | 4 | 21 | 2 | 2 | 3 |
| 4/25/44 | 20 | 20 | 20 | 15 | 8 | 14 | 0 | 0 | 0 | - | - | - |
| 5/25/44 | 20 | 20 | 20 | 2 | 4 | 10 | 0 | 0 | 0 | - | - | - |
| 6/25/44 | 20 | 20 | 20 | 5 | 2 | 20 | 0 | 0 | 0 | - | - | - |
| 7/25/44 | 20 | 20 | 20 | 0 | 1 | 0 | 0 | 0 | 0 | - | - | - |
| 8/25/44 | 20 | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| TOTALS | 812 | 670 | 530 | 268 | 99 | 143 | 107 | 449 | 630 | 4.66" | 6.88" | 8.44" |

## SANSEVIERIA REPRODUCTION FROM RHIZOMES

One of the most commonly used methods of propagating sansevieria is the planting of the underground rootstocks, or rhizomes. As ornamental planting stock, rhizomes have a distinct advantage over leaf cuttings in that they come "true", that is, all of the plant characters of the parent stock are transmitted as they are in seed. Leaf cuttings do not possess this power of character transmittal, since some of the plant characters are not carried in the somatic bud tissue.

### METHODS OF PLANTING RHIZOMES

In the field plantings of sansevieria for fiber investigations, approximately two acres were planted with rhizomes. As no information regarding the use of rhizomes as propagating material was available, several different methods of planting were used. In one test the rhizomes were cut into sections 3" and 5" in length and were planted in rows 18" wide and 350 feet long. The sections were spaced one inch apart in the drill. In another test the rhizomes were not cut into any definite lengths, but were planted in the drill just as they were dug from the ground. Instead of leaving a space between the sections, they were planted with the ends touching each other in the drill. Row width and length were the same as for the 3" and 5" sections. In both tests there were 21 rows in each block.

These two tests constituted the main rhizome plantings but two smaller plantings which will be referred to subsequently in this paper, were made for testing other factors.

All planting was done by hand, half-bushel baskets being used to hold the rhizomes when they were unloaded in the field. A special type of machine was used to open the furrows, 5 rows being opened in a single operation. The rhizomes were covered 2" deep. All plantings were made during the last week in March, 1943. The type of soil on which the plantings were made is a Leon Fine Sandy Loam. Because of the extremely dry weather in the spring and early summer of 1943, very few plants came up until several weeks after the summer rains had started in late June. Standard 4-7-5 fertilizer was applied every three months at the rate of 600 pounds per acre, one-third of this amount being used at each application.

A plant count made on December 15, 1943, showed that the 3" and 5" rhizome blocks had 5800 plants per block, while the rhizomes planted solidly had 6000 plants per block. A second check made on November 15, 1944, showed that the rhizome beds planted solidly had approximately twice as many plants per bed as the 3" and 5" beds. At no time have the plants multiplied as rapidly as they do from whole plants, cut-back plants or leaf cuttings.

## A SPECIAL CHARACTER OF RHIZOMES

Although a fairly satisfactory stand of plants was eventually obtained from the rhizome plantings, the plants were not suitable for fiber purposes since all of the first plants that come directly from the rhizomes are rosette in form; that is, the leaves are short and spread out horizontally instead of growing upright or vertically. The second plant which arises from a rhizome produced by the first plant is usually an intermediate plant in height; that is, it is neither a true rosette nor a true upright plant. However, the third plant which is produced from the second plant is a true upright and produces leaves suitable for fiber purposes.

Thus, rhizomes, like seed require a rather long period before fully upright plants are produced, probably two years or longer. Also, like seed, rhizomes presumably carry all of the plant characters of the parent stock. They first produce rosette leaves which is a typically juvenile character. Unlike the leaves produced by seedlings, the first leaves produced by rhizomes have all of the colors of the upright character leaf of the parent stock. The first leaves of plants produced from seed do not show true "character", but "character" leaves are gradually acquired. This is one of the fundamental differences between plants produced from seed and plants produced from rhizomes.

## ROOTS FORMED BY RHIZOMES

Unlike leaf cuttings or seeds, rhizomes do not put out any small roots, but a new primary rhizome develops directly from the old rhizome. From this primary rhizome new lateral roots emerge as soon as the shoot is above the surface of the ground.

# SANSEVIERIA REPRODUCTION FROM SEED

It is generally known that most species of sansevieria produce but few seeds or none at all. A review of the literature on sansevieria furnishes but little information regarding the production of seed by this plant. Augusto Perez Toro(1) states that sansevieria may be reproduced from seed but that the plants grow slowly and are unsatisfactory for fiber. No details are given. Ricardo Loret De Mola(2) mentions that sansevieria can be grown from seed but gives no details. The lack of information on this subject indicated the advisability of initiating a series of experiments in growing sansevieria from seed, for the purpose of obtaining additional information concerning the growth habits of the different species now being grown experimentally in the United States for the production of fiber.

---

1. Augusto Perez Toro. El Cultivo de la Sansevieria in Yucatan. p. 16. 1942.

2. Ricardo Loret De Mola.

It was apparent that more complete data on this subject would be useful not only in connection with the utilization of these plants for the production of fiber, but also from a horticultural viewpoint. Relatively large quantities of certain species of sansevieria are now grown by horticulturists for use as ornamental household plants. There is a large demand for these plants, and any new facts relating to the growth habits of the species used as ornamentals would be useful in this field. The experiments in growing sansevieria plants from seed were undertaken as a part of a sansevieria investigational project started in 1943, and conducted by the United States Department of Agriculture and cooperating agencies near Boynton, Florida. This paper covers only preliminary results obtained in experiments that are still in progress.

The principal species now being grown for fiber in the experimental work near Boynton is Sansevieria metallica. Though indigenous to Africa, this species now occurs in patches of wild or semi-wild plants throughout South Florida on both the east and west coasts. It may also be found in many door-yards where it is grown as an ornamental plant. It does not produce any seed under Florida conditions. It is not known if seed is produced by this species in its native habitat in Africa. The flowers of some plants produce abundant pollen, but in most flowers the pistil has been reduced to a pistillode which remains sterile. A few linocarps have been found on several wild plants indicating that development of the seed had begun but was not completed.

In contrast to *S. metallica*, the two principal ornamental species *S. zeylanica* and *S. lorentii* both produce seed though *lorentii* has been found with seed in only one locality in Miami, Florida. Seed production is rare, however, even with the ornamental species. The Florida growers of sansevieria plants that are to be used for ornamental purposes obtain their new stocks by asexual methods of propagation, and are not familiar with seed production.

Seeds have been found on *A. zeylanica* in Miami, Arcadia and Sebring, indicating that this species seeds more freely than *A. lorentii*, though the latter grows as freely and vigorously in these places as does *zeylanica*. One other species, not yet definitely identified, but probably *S. longiflora* or *S. rotundaflora*, at Sebring, Florida, also produces seed. The seeds of this species were not ripe when the plants were last inspected on August 20, 1944. One plant of *A. zeylanica* in the experimental plots produced fruit in September, 1944, but the fruits have not yet reached maturity (fig. ?).

In June, 1943, 25 seeds were obtained from plants of *S. zeylanica* in Arcadia, Florida. These seeds had been ripe for some time and 15 were partly shriveled. These 25 seeds were planted on June 19, and 6 of them germinated during the last week of July. No further germination was obtained with this lot of seed, probably due either to imperfect fertilization or to the fact that the seed had dried out sufficiently to kill the embryo.

Two other lots of seed that had been received from the American Consulate, Nairobi, Kenya, Africa, were also planted on June 19. The first lot, under P. I. number 146175, contained 32 seeds. On July 8, six of these seeds had germinated, and on July 31, fourteen plants were above ground. At this time these plants were sufficiently large for transplanting from the seed bed to pots. No further germination was obtained from this lot of seed. The second lot, under P. I. number 146174, contained 10 seeds. On July 8, six of these seeds had germinated. No further germination was obtained from this lot. The species of sansevieria from which these two lots of seed were obtained is not known. Photographs made of these plants on September 18, 1943, indicate that the seeds in these two lots were obtained from the same species. There are, however, marked differences between the African plants and those of *S. zeylanica*, which are shown by the leaves of the seedlings even in the very early stages of development. *S. zeylanica* has a narrow leaf with a sharp pointed tip, whereas the African species has a broad leaf with a distinct marginal border, and with the apex much less pointed than in *zeylanica*. Another contrasting feature of the two species is the finely mottled upper surface of leaves of the African type, whereas the leaves of *zeylanica* have a smooth upper surface entirely without spots.

A second lot of seed of *S. zeylanica* and *S. lorentii* was obtained in Miami, Florida, on July 15, 1944. Fifty seeds of *S. zeylanica* and 6 seeds of *S. lorentii* were planted on July 17, 1944. On August 5, forty-five seeds of *S. zeylanica* and 4 of *S. lorentii* had germinated. All of these seeds were freshly ripe when gathered and doubtless this factor contributed to the high percentage of germination.

## LENGTH OF TIME REQUIRED FOR GERMINATION

About six weeks was required for the germination of the seeds of S. zeylanica obtained from Arcadia. Six seeds of one lot of the African species germinated in three weeks, and six weeks after planting 14 plants of this group were sufficiently large for transplanting from the seed bed to pots. Six plants of the second lot of African seed had emerged in less than three weeks after planting, indicating a much shorter germinating period for the African seed as compared with that of the S. zeylanica, from Arcadia. However, the Miami lot of seed of S. zeylanica compared favorably with the African seed in length of time required for germination.

## DEVELOPMENT OF SEEDLINGS

Seedlings from the first lot of Arcadia seed were potted in 2-inch pots when 30 days old and placed outdoors in a half-shade. The plants grew rapidly for a few weeks until the first six or eight leaves had formed, and then they grew very slowly for a period of nearly eight months. This slow growth doubtless was prolonged by the rather cold nights of the winter months, and the fact that the plants remained in small pots. At the end of one year these plants were still small with only six to ten leaves, typically rosette in form. In July, 1944, the plants were transferred to 4-inch pots and rapid growth began. The characteristic color of the "character" leaf was distinctly visible in the S. zeylanica by September, and the leaves began to assume a more upright position indicating the beginning of the formation of petioles that are a part of the "character" leaf. By this time a large mass of fibrous roots had been formed on the plants.

## PREPARATION OF SEED BED

The seed bed consisted of light sand mixed with one part muck. This soil mixture was placed in a flat to a depth of four inches when firmly pressed down. The seeds were planted one inch apart in check rows and were pressed into the soil and very lightly covered with soil firmly pressed down. Before planting, the seeds were cleaned of all pulp by washing in warm water. The seed flat was kept in a half-shade and the soil was kept moist at all times, but not soggy, until germination of the seeds was complete.

## JUVENILE ROOT SYSTEM

When germination begins, two roots resembling small tap roots emerge almost directly from the seed. These roots grow about two inches long and are a typical orange-red color. At this stage of growth most of the plant's nourishment is still supplied by the slowly digesting seed. After the shoots appear above ground a few additional roots are formed, but several weeks elapse before the fine lateral roots begin to branch out from the minature tap roots. During this period the plants grow slowly. As more lateral roots develop, rapidity of growth increases and when a large mass of fibrous roots has been formed the plants begin to grow very fast. During the stage when the mass of fibrous roots is being formed, there is no sign of the appearance of rhizomes. When leaf cuttings are rooted, no long vertical roots are formed, but only short white roots that are soon followed by branching lateral roots. The fibrous roots thus formed are soon followed by the formation of rhizomes which, in turn, produce a new shoot above ground. The fundamental difference between seed-produced plants and plants produced from leaf cuttings is that seedling plants produce no rhizomes before "character" leaves are formed.

## DESCRIPTION OF FRUIT AND SEED

The green fruits of S. zeylanica are about one-fourth inch in diameter. At maturity the seed is covered with a very thin fleshy pulp. In Arcadia, Florida, the plants bloom in January and February and the fruits ripen in late June and early July. Once the fruits begin to ripen only a few days elapse before they are completely ripe. When fully ripe the fruits are a bright orange-red color, and usually remain on the plant for only a few days before dropping. A normally matured fruit contains three cells with each cell containing one seed, but most of the fruits that have been found were either single or double-celled. After the fruit is ripe the thin soft pulp separates readily from the seed which is white in color, hard, and slightly oval in shape. Like many of the palm seeds, the seeds of sansevieria are composed largely of albumen and a slow germination would, therefore, be expected. The surface is smooth and the embryo is readily visible to the naked eye as a minute dark-colored spot, sometimes slightly elevated above the surface of the seed and very shallow. This indicates that the seed would be very perishable if allowed to dry out for any appreciable length of time. The poor germination of the sansevieria seed received from Africa may have been partly due to excessive drying out during transit.

## JUVENILE LEAVES

As indicated elsewhere, germination takes place rather rapidly. The first two or three leaves appear above ground as bladeless sheaths followed in turn by succeeding leaves, very minute at first, but each leaf slightly larger than the one preceding, until the juvenile leaves reach full size. At emergence, the leaves are almost vertical but as they grow older they spread out and assume a more horizontal position, giving the plant the characteristic "rosette" form. This rosette form is a definitely juvenile character and the plants remain in this stage for many months before upright leaves are formed, even though the character leaf may be distinguished in the rosette stage. Another feature of juvenile leaves is that they have no petiole as do the adult upright leaves. The length of the juvenile period will vary under different conditions of growth, but at least two years will probably be required before upright leaves with full petioles are formed. It is likely that true upright leaves will not form until rhizomes are produced. Since only upright leaves are suitable for fiber, this characteristic feature of young seedling plants having only rosette leaves renders the use of seed undesirable as a propagating material where an early upright leaf is desired. From a breeding standpoint, however, where the production of hybrids is desired, the growing of plants from seed would be an advantage. It is likely, also, that definite strains or varieties of seed-bearing plants could be obtained by selection from plants that were grown from seed. In the ornamental field this would be desirable as the rosette type of plant is required by the ornamental trade.

# SANSEVIERIA REPRODUCTION FROM LEAF CUTTINGS

Experiments were initiated in the early summer of 1943 for the purpose of determining the feasibility of using leaf cuttings of sansevieria as a source of planting stock for possible commercial plantings. Plantings were made each month, beginning in July, to test the possible effects of different dates of planting, and different parts of the leaf were used as planting stock. The parts of the leaf used were the base of the petiole, sections from the middle of the leaf blade and the tip end of the leaf. This paper deals with the results obtained during the first 14 months of these experiments.

## Plan of Experiments

Each experiment included from 20 to 100 sections of each type of planting stock, and plantings were made on the 25th day of each month. The sections were planted 4 inches deep in a very light sandy soil in rows 6 feet wide, and were spaced 2 inches apart in the drill. All planting stock used consisted of leaves of wild plants, all of which were obtained from the same source. The sections were cut 12 inches in length and only whole cross sections of the plant were used; that is, the leaf or petiole was not split vertically in this series of experiments. In an earlier experiment, which will be discussed briefly in this paper, two rows of leaf cuttings, in which the sections were split vertically, were planted. Fresh planting stock was always used, each planting being made within two or three hours after the material had been cut. None of the plantings were watered at any time.

The tabulated results of the 14 monthly plantings are shown in table 1. In general it has been found that the best results are obtained with the tip sections, followed in turn by the middle sections of the leaf and by the petiole sections last. The petiole sections not only germinate the least satisfactorily but each section usually produces only one plant, whereas, the middle and tip sections both produce several plants from each section. The number of sections of each type of material planted during this period was 712 base, 570 middle and 430 tip. The number of each type that died was 246 base, 85 middle and 99 tip sections, leaving 466 base sections, 485 middle and 331 tip alive on September 1, 1944. For the first nine months only 107 plants had been produced by the 466 base sections, compared with 449 plants produced by the 485 middle sections and 630 plants by the 331 tip sections. Thus, for the first nine months the base sections averaged less than one plant per four sections, whereas, the middle sections averaged almost one plant per section and the tips almost two plants per section. The tip section has consistently given the best results. Not only does the tip section produce more plants, but also it roots the most rapidly and the plants grow more rapidly than those produced by the middle and basal sections. In some cases, sections of all three types were still alive on September 1, 1944, but had not produced any plants above ground. It is possible, therefore, that the number of plants ultimately obtained from each type of material may vary somewhat from the present records of production. It appears unlikely, however, that the basal sections will ever approach the averages of the middle and tip sections.

## LENGTH OF TIME REQUIRED TO PRODUCE ROOTS, RHIZOMES AND PLANTS

Tips: Under favorable conditions tip sections will produce roots in 20 days and rhizomes in 70 to 90 days. Also under favorable conditions, from 90 to 120 days will elapse before new plants appear above ground from rooted cuttings. During the dry winter and spring months, as shown in table 1, this period may be as long as five months. From January until July, 1944, was an extremely dry period and no plants appeared above ground from any of the monthly plantings made after March of this period, although adventitious roots formed on many sections of cuttings pla nted in April, May, June and July. It is believed that insufficient moisture prevented the formation of rhizomes from which the new plants are formed.

Middle Sections: The results obtained with middle sections of the leaf are in general similar to the results obtained with the tips, except that adventitious roots form a little more slowly than with the tip sections. Also, rhizomes are formed a little more slowly, and the number of rhizomes produced by a section of given size are less than with a tip section of the same size. Plate No.      shows two middle sections, one 25 days old and one 50 days old. A notable feature of the roots on the 25-day-old section is that they are simple straight roots, not branched and white in color. These function in a manner similar to tap roots and may be regarded as modified tap roots. The roots on the 50-day-old section are branched and have the typical orange-red color. All of the roots in both sections arise deep in the tissues of the leaf rather than on the surface, though the mass of red branched roots is closer to the surface than are the white unbranched roots. The 50-day-old section shows no signs of forming rhizomes even though the mass of fibrous roots is large.

Once the tip and middle sections begin to form roots, the portion above ground acts as a new plant, furnishing a supply of plant food to the root system which rapidly expands until a mass of roots is formed. These sections remain green even after many new plants have been produced above ground, showing that the leaf is still active in the manufacture of plant food.

Base Sections: Base sections of the petiole require 60 to 90 days before adventitious roots appear, and even then only a few roots are formed. The lack of adventitious buds in the petiole section prevents the formation of many roots. Even after the roots are formed they usually remain small, which is probably due to the lack of chlorophyll in the petiole section. This would naturally result in less plant food with which to build a vigorous root system.

## SYSTEM OF ROOT DEVELOPMENT

In the development of new plants from leaf cuttings, three distinct growth periods or phases may be recognized. The first covers the formation of the scattered, unbranched adventitious roots, while the second signalizes the formation of a mass of branched roots characteristically red in color. Following these two periods is the formation of rhizomes and the appearance above ground of the new plant.

Like the adventitious roots, the rhizomes arise from inner bud tissue at the very base of the cut section, though just how the rhizome buds are differentiated from the other buds which form masses of fibrous roots is a physiological factor not yet clearly understood. Also, the fact that when rhizomes are planted, new rhizomes are formed without the formation of any fibrous roots is an interesting physiological phenomenon not found in the rooting of leaf cuttings, where masses of fibrous roots always precede the formation of rhizomes.

Rhizomes from rooted leaf cuttings almost invariably grow horizontally for two or three inches from the leaf section and then assume a vertical position. They are also white in color when first formed like the first unbranched roots. Thus there are three stages of specialized root development; first, white unbranched roots, followed by masses of red roots and then by white rhizomes. No roots are formed on the rhizome until the shoot appears above ground. As soon as the shoot appears above the surface of the soil lateral roots with branches form rapidly along the rhizomes. The same stage of root development is repeated on the rhizome as in the leaf section, namely, white unbranched roots are formed first, followed by many branched red-colored roots. Eventually the entire rhizome turns orange-red.

## TYPE OF PLANTS PRODUCED BY LEAF CUTTINGS

Unlike seed and rhizomes, which produce plants of the rosette or partially upright type, all of the plants obtained from whole sections of leaf cuttings are upright in form. This habit of producing upright plants is a distinct advantage from a fiber standpoint since only leaves with long petioles are suitable for fiber. The elimination of the intermediate stages of passing from rosette to upright leaves greatly shortens the period of time required to mature leaves suitable for fiber purposes. Compared with rosette plants, this growth habit of leaf cuttings shortens the growing period from planting to maturity by as much as a year or longer when a fiber leaf is the primary consideration.

## LEAF CUTTINGS SPLIT VERTICALLY

In August, 1942, before the series of experiments discussed in this paper had been planned, a few leaf sections that had been split vertically into halves, thirds, fourths and eights were planted. Only middle and tip sections were used. All of these rooted readily, but the smaller sections produced only one plant each. Also, unlike the whole sections, the smaller sections produced only rosette plants which were very small and weak. All of these sections were transplanted from a field where they were first rooted to their present location adjoining the monthly experiments. Transplanting was done during dry weather and the plants were injured severely though but few died. The present vigorous condition of these plants is shown in Plate . The rosette plants obtained from the small split-leaf sections is the only instance noted where rosette plants have been produced from leaf cuttings.

## COMMERCIAL PLANTING OF LEAF CUTTINGS

Leaf cuttings were planted experimentally on a commercial scale in the spring of 1943, but most of these plants died, due primarily to the extremely dry weather and the small size of the leaf section which caused them to rapidly dry out and shrivel in the hot, dry sandy soil. Many of the leaf sections were split vertically into small sections, which subsequent investigations have shown was an error. Also, much of the stock used was several days old, rather than freshly cut material, a factor that is detrimental where leaf cuttings are used for planting stock.

An efficient leaf-cutting machine for preparing leaf sections on a commercial scale, which is driven by a 1/4 H.P. electric motor, was designed and built by Mr. Oscar, R. Winchester. This machine is so designed that each leaf section is cut with a fork in the end which goes into the ground. This was done in order that the sections might be planted without reversing their polarity; that is, to avoid turning the sections up side down. Except in rare cases, leaf cuttings planted with the ends reversed will not root. In the experimental work that has thus far been done, not a single leaf section with the ends reversed has rooted in the field.

This leaf-cutting machine is easily operated and a large quantity of planting material can be prepared in a relatively short period of time. The length of the leaf section is readily regulated by means of an adjustable backstop, which is shown in Plate . As the sections are cut they fall into a 2-bushel crate. When the required number of crates of planting material have been prepared they are taken to the field by truck. Planting is done by hand.

Although this particular experiment was not successful, this does not necessarily mean that the use of leaf cuttings as planting stock is impracticable. Information now available indicates that if the leaves are freshly cut, properly prepared, and planted under suitable temperature and moisture conditions, a satisfactory stand of plants is likely to be obtained. The advantages of leaf cuttings for planting stock are that they are cheap, easy to plant, and will produce a large number of plants of the right type for fiber. Also, a growth of plants sufficiently dense to crowd out the weeds is obtained, which is a very important item in getting a crop of sansevieria started.

| Date of Planting | Number and Kind of Leaf Sections Planted |  |  | Number of Sections Dead on September 1, 1944 |  |  | Number of Plants Produced from all Sections of each Type of Cutting by Sept. 1, 1944 |  |  | Average Height in Inches of Plants Produced by each Type of Cutting - September 1, 1944 |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Base | Middle | Tip | Base | Middle | Tip | Base | Middle | Tip | Base | Middle | Tip |
| 7/25/43 | 60 | 50 | 50 | 25 | 10 | 30 | 22 | 75 | 50 | 6" | 10" | 12" |
| 8/25/43 | 70 | 70 | 70 | 2 | 2 | 2 | 33 | 96 | 215 | 8 | 12 | 15 |
| 9/25/43 | 100 | 100 | 100 | 45 | 25 | 25 | 24 | 65 | 152 | 8 | 8 | 12 |
| 10/25/43 | 125 | 100 | 50 | 34 | 18 | 5 | 16 | 106 | 90 | 6 | 12 | 12 |
| 11/25/43 | 150 | 75 | 40 | 96 | 18 | 24 | 5 | 50 | 32 | 4 | 6 | 6 |
| 12/26/43 | 32 | 20 | 15 | 25 | 2 | 3 | 1 | 12 | 15 | 3 | 4 | 6 |
| 1/25/44 | 50 | 30 | 20 | 5 | 3 | 2 | 2 | 25 | 25 | 2 | 5 | 6 |
| 2/25/44 | 50 | 75 | 50 | 8 | 4 | 3 | 1 | 17 | 30 | 3 | 3 | 4 |
| 3/25/44 | 75 | 50 | 35 | 8 | 2 | 5 | 3 | 4 | 21 | 2 | 2 | 3 |
| 4/25/44 | 20 | 20 | 20 | 15 | 8 | 14 | 0 | 0 | 0 | - | - | - |
| 5/25/44 | 20 | 20 | 20 | 2 | 4 | 10 | 0 | 0 | 0 | - | - | - |
| 6/25/44 | 20 | 20 | 20 | 5 | 2 | 20 | 0 | 0 | 0 | - | - | - |
| 7/25/44 | 20 | 20 | 20 | 0 | 1 | 0 | 0 | 0 | 0 | - | - | - |
| 8/25/44 | 20 | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| TOTALS | 812 | 670 | 530 | 268 | 99 | 143 | 107 | 449 | 630 | 4.66" | 6.55" | 8.44" |

## SANSEVIERIA REPRODUCTION FROM LEAF CUTTINGS

Experiments were initiated in the early summer of 1948 for the purpose of determining the feasibility of using leaf cuttings of sansevieria as a source of planting stock for possible commercial plantings. Plantings were made each month, beginning in July, to test the possible effects of different dates of planting, and different parts of the leaf were used as planting stock. The parts of the leaf used were the base of the petiole, sections from the middle of the leaf blade and the tip end of the leaf. This paper deals with the results obtained during the first 14 months of these experiments.

### Plan of Experiments

Each experiment included from 20 to 100 sections of each type of planting stock, and plantings were made on the 25th day of each month. The sections were planted 4 inches deep in a very light sandy soil in rows 6 feet wide, and were spaced 2 inches apart in the drill. All planting stock used consisted of leaves of wild plants, all of which were obtained from the same source. The sections were cut 12 inches in length and only whole cross sections of the plant were used; that is, the leaf or petiole was not split vertically in this series of experiments. In an earlier experiment, which will be discussed briefly in this paper, two rows of leaf cuttings, in which the sections were split vertically, were planted. Fresh planting stock was always used, each planting being made within two or three hours after the material had been cut. None of the plantings were watered at any time.

The tabulated results of the 14 monthly plantings are shown in table 1. In general it has been found that the best results are obtained with the tip sections, followed in turn by the middle sections of the leaf and by the petiole sections last. The petiole sections not only germinate the least satisfactorily but each section usually produces only one plant, whereas, the middle and tip sections both produce several plants from each section. The number of sections of each type of material planted during this period was 712 base, 570 middle and 430 tip. The number of each type that died was 246 base, 85 middle and 99 tip sections, leaving 466 base sections, 485 middle and 331 tip alive on September 1, 1944. For the first nine months only 107 plants had been produced by the 466 base sections, compared with 449 plants produced by the 485 middle sections and 630 plants by the 331 tip sections. Thus, for the first nine months the base sections averaged less than one plant per four sections, whereas, the middle sections averaged almost one plant per section and the tips almost two plants per section. The tip section has consistently given the best results. Not only does the tip section produce more plants, but also it roots the most rapidly and the plants grow more rapidly than those produced by the middle and basal sections. In some cases, sections of all three types were still alive on September 1, 1944, but had not produced any plants above ground. It is possible, therefore, that the number of plants ultimately obtained from each type of material may vary somewhat from the present records of production. It appears unlikely, however, that the basal sections will ever approach the averages of the middle and tip sections.

## LENGTH OF TIME REQUIRED TO PRODUCE ROOTS, RHIZOMES AND PLANTS

Tips: Under favorable conditions tip sections will produce roots in 20 days and rhizomes in 70 to 90 days. Also under favorable conditions, from 90 to 120 days will elapse before new plants appear above ground from rooted cuttings. During the dry winter and spring months, as shown in table 1, this period may be as long as five months. From January until July, 1944, was an extremely dry period and no plants appeared above ground from any of the monthly plantings made after March of this period, although adventitious roots formed on many sections of cuttings pla nted in April, May, June and July. It is believed that insufficient moisture prevented the formation of rhizomes from which the new plants are formed.

Middle Sections: The results obtained with middle sections of the leaf are in general similar to the results obtained with the tips, except that adventitious roots form a little more slowly than with the tip sections. Also, rhizomes are formed a little more slowly, and the number of rhizomes produced by a section of given size are less than with a tip section of the same size. Plate No.      shows two middle sections, one 25 days old and one 50 days old. A notable feature of the roots on the 25-day-old section is that they are simple straight roots, not branched and white in color. These function in a manner similar to tap roots and may be regarded as modified tap roots. The roots on the 50-day-old section are branched and have the typical orange-red color. All of the roots in both sections arise deep in the tissues of the leaf rather than on the surface, though the mass of red branched roots is closer to the surface than are the white unbranched roots. The 50-day-old section shows no signs of forming rhizomes even though the mass of fibrous roots is large.

Once the tip and middle sections begin to form roots, the portion above ground acts as a new plant, furnishing a supply of plant food to the root system which rapidly expands until a mass of roots is formed. These sections remain green even after many new plants have been produced above ground, showing that the leaf is still active in the manufacture of plant food.

Base Sections: Base sections of the petiole require 60 to 90 days before adventitious roots appear, and even then only a few roots are formed. The lack of adventitious buds in the petiole section prevents the formation of many roots. Even after the roots are formed they usually remain small, which is probably due to the lack of chlorophyll in the petiole section. This would naturally result in less plant food with which to build a vigorous root system.

## SYSTEM OF ROOT DEVELOPMENT

In the development of new plants from leaf cuttings, three distinct growth periods or phases may be recognized. The first covers the formation of the scattered, unbranched adventitious roots, while the second signalizes the formation of a mass of branched roots characteristically red in color. Following these two periods is the formation of rhizomes and the appearance above ground of the new plant.

Like the adventitious roots, the rhizomes arise from inner bud tissue at the very base of the cut section, though just how the rhizome buds are differentiated from the other buds which form masses of fibrous roots is a physiological factor not yet clearly understood. Also, the fact that when rhizomes are planted, new rhizomes are formed without the formation of any fibrous roots is an interesting physiological phenomenon not found in the rooting of leaf cuttings, where masses of fibrous roots always precede the formation of rhizomes.

Rhizomes from rooted leaf cuttings almost invariably grow horizontally for two or three inches from the leaf section and then assume a vertical position. They are also white in color when first formed like the first unbranched roots. Thus there are three stages of specialized root development; first, white unbranched roots, followed by masses of red roots and then by white rhizomes. No roots are formed on the rhizome until the shoot appears above ground. As soon as the shoot appears above the surface of the soil lateral roots with branches form rapidly along the rhizomes. The same stage of root development is repeated on the rhizome as in the leaf section, namely, white unbranched roots are formed first, followed by many branched red-colored roots. Eventually the entire rhizome turns orange-red.

## TYPE OF PLANTS PRODUCED BY LEAF CUTTINGS

Unlike seed and rhizomes, which produce plants of the rosette or partially upright type, all of the plants obtained from whole sections of leaf cuttings are upright in form. This habit of producing upright plants is a distinct advantage from a fiber standpoint since only leaves with long petioles are suitable for fiber. The elimination of the intermediate stages of passing from rosette to upright leaves greatly shortens the period of time required to mature leaves suitable for fiber purposes. Compared with rosette plants, this growth habit of leaf cuttings shortens the growing period from planting to maturity by as much as a year or longer when a fiber leaf is the primary consideration.

## LEAF CUTTINGS SPLIT VERTICALLY

In August, 1942, before the series of experiments discussed in this paper had been planned, a few leaf sections that had been split vertically into halves, thirds, fourths and eights were planted. Only middle and tip sections were used. All of these rooted readily, but the smaller sections produced only one plant each. Also, unlike the whole sections, the smaller sections produced only rosette plants which were very small and weak. All of these sections were transplanted from a field where they were first rooted to their present location adjoining the monthly experiments. Transplanting was done during dry weather and the plants were injured severely though but few died. The present vigorous condition of these plants is shown in Plate . The rosette plants obtained from the small split-leaf sections is the only instance noted where rosette plants have been produced from leaf cuttings.

## COMMERCIAL PLANTING OF LEAF CUTTINGS

Leaf cuttings were planted experimentally on a commercial scale in the spring of 1943, but most of these plants died, due primarily to the extremely dry weather and the small size of the leaf section which caused them to rapidly dry out and shrivel in the hot, dry sandy soil. Many of the leaf sections were split vertically into small sections, which subsequent investigations have shown was an error. Also, much of the stock used was several days old, rather than freshly cut material, a factor that is detrimental where leaf cuttings are used for planting stock.

An efficient leaf-cutting machine for preparing leaf sections on a commercial scale, which is driven by a 1/4 H.P. electric motor, was designed and built by Mr. Oscar, R. Winchester. This machine is so designed that each leaf section is cut with a fork in the end which goes into the ground. This was done in order that the sections might be planted without reversing their polarity; that is, to avoid turning the sections up side down. Except in rare cases, leaf cuttings planted with the ends reversed will not root. In the experimental work that has thus far been done, not a single leaf section with the ends reversed has rooted in the field.

This leaf-cutting machine is easily operated and a large quantity of planting material can be prepared in a relatively short period of time. The length of the leaf section is readily regulated by means of an adjustable backstop, which is shown in Plate . As the sections are cut they fall into a 2-bushel crate. When the required number of crates of planting material have been prepared they are taken to the field by truck. Planting is done by hand.

Although this particular experiment was not successful, this does not necessarily mean that the use of leaf cuttings as planting stock is impracticable. Information now available indicates that if the leaves are freshly cut, properly prepared, and planted under suitable temperature and moisture conditions, a satisfactory stand of plants is likely to be obtained. The advantages of leaf cuttings for planting stock are that they are cheap, easy to plant, and will produce a large number of plants of the right type for fiber. Also, a growth of plants sufficiently dense to crowd out the weeds is obtained, which is a very important item in getting a crop of sansevieria started.

| Date of Planting | Number and Kind of Leaf Sections Planted<br>Base-Middle-Tip | | | Number of Sections Dead on September 1, 1944<br>Base-Middle-Tip | | | Number of Plants Produced from all Sections of each Type of Cutting by Sept. 1, 1944<br>Base-Middle-Tip | | | Average Height in Inches of Plants Produced by each Type of Cutting - September 1, 1944<br>Base-Middle-Tip | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/25/43 | 60 | 50 | 50 | 25 | 10 | 30 | 22 | 75 | 50 | 6" | 10" | 12" |
| 8/25/43 | 70 | 70 | 70 | 2 | 2 | 2 | 33 | 96 | 215 | 8 | 12 | 15 |
| 9/25/43 | 100 | 100 | 100 | 43 | 25 | 25 | 24 | 65 | 152 | 8 | 6 | 12 |
| 10/25/43 | 125 | 100 | 50 | 34 | 18 | 5 | 16 | 105 | 90 | 6 | 12 | 12 |
| 11/25/43 | 150 | 75 | 40 | 96 | 18 | 24 | 5 | 50 | 32 | 4 | 6 | 6 |
| 12/25/43 | 32 | 20 | 15 | 25 | 2 | 3 | 1 | 12 | 15 | 3 | 4 | 6 |
| 1/25/44 | 50 | 30 | 20 | 5 | 3 | 2 | 2 | 25 | 25 | 2 | 5 | 6 |
| 2/25/44 | 50 | 75 | 50 | 8 | 4 | 3 | 1 | 17 | 30 | 3 | 3 | 4 |
| 3/25/44 | 75 | 50 | 35 | 6 | 2 | 5 | 3 | 4 | 21 | 2 | 2 | 3 |
| 4/25/44 | 20 | 20 | 20 | 15 | 8 | 14 | 0 | 0 | 0 | - | - | - |
| 5/25/44 | 20 | 20 | 20 | 2 | 4 | 10 | 0 | 0 | 0 | - | - | - |
| 6/25/44 | 20 | 20 | 20 | 5 | 2 | 20 | 0 | 0 | 0 | - | - | - |
| 7/25/44 | 20 | 20 | 20 | 0 | 1 | 0 | 0 | 0 | 0 | - | - | - |
| 8/25/44 | 20 | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| TOTALS | 812 | 670 | 530 | 266 | 99 | 143 | 107 | 449 | 630 | 4.66" | 6.66" | 8.44" |

# SANSEVIERIA REPRODUCTION FROM LEAF CUTTINGS

Experiments were initiated in the early summer of 1943 for the purpose of determining the feasibility of using leaf cuttings of sansevieria as a source of planting stock for possible commercial plantings. Plantings were made each month, beginning in July, to test the possible effects of different dates of planting, and different parts of the leaf were used as planting stock. The parts of the leaf used were the base of the petiole, sections from the middle of the leaf blade and the tip end of the leaf. This paper deals with the results obtained during the first 14 months of these experiments.

## Plan of Experiments

Each experiment included from 20 to 100 sections of each type of planting stock, and plantings were made on the 25th day of each month. The sections were planted 4 inches deep in a very light sandy soil in rows 6 feet wide, and were spaced 2 inches apart in the drill. All planting stock used consisted of leaves of wild plants, all of which were obtained from the same source. The sections were cut 12 inches in length and only whole cross sections of the plant were used; that is, the leaf or petiole was not split vertically in this series of experiments. In an earlier experiment, which will be discussed briefly in this paper, two rows of leaf cuttings, in which the sections were split vertically, were planted. Fresh planting stock was always used, each planting being made within two or three hours after the material had been cut. None of the plantings were watered at any time.

The tabulated results of the 14 monthly plantings are shown in table 1. In general it has been found that the best results are obtained with the tip sections, followed in turn by the middle sections of the leaf and by the petiole sections last. The petiole sections not only germinate the least satisfactorily but each section usually produces only one plant, whereas, the middle and tip sections both produce several plants from each section. The number of sections of each type of material planted during this period was 712 base, 570 middle and 430 tip. The number of each type that died was 246 base, 85 middle and 99 tip sections, leaving 466 base sections, 485 middle and 331 tip alive on September 1, 1944. For the first nine months only 107 plants had been produced by the 466 base sections, compared with 449 plants produced by the 485 middle sections and 630 plants by the 331 tip sections. Thus, for the first nine months the base sections averaged less than one plant per four sections, whereas, the middle sections averaged almost one plant per section and the tips almost two plants per section. The tip section has consistently given the best results. Not only does the tip section produce more plants, but also it roots the most rapidly and the plants grow more rapidly than those produced by the middle and basal sections. In some cases, sections of all three types were still alive on September 1, 1944, but had not produced any plants above ground. It is possible, therefore, that the number of plants ultimately obtained from each type of material may vary somewhat from the present records of production. It appears unlikely, however, that the basal sections will ever approach the averages of the middle and tip sections.

## LENGTH OF TIME REQUIRED TO PRODUCE ROOTS, RHIZOMES AND PLANTS

Tips: Under favorable conditions tip sections will produce roots in 20 days and rhizomes in 70 to 90 days. Also under favorable conditions, from 90 to 120 days will elapse before new plants appear above ground from rooted cuttings. During the dry winter and spring months, as shown in table 1, this period may be as long as five months. From January until July, 1944, was an extremely dry period and no plants appeared above ground from any of the monthly plantings made after March of this period, although adventitious roots formed on many sections of cuttings planted in April, May, June and July. It is believed that insufficient moisture prevented the formation of rhizomes from which the new plants are formed.

Middle Sections: The results obtained with middle sections of the leaf are in general similar to the results obtained with the tips, except that adventitious roots form a little more slowly than with the tip sections. Also, rhizomes are formed a little more slowly, and the number of rhizomes produced by a section of given size are less than with a tip section of the same size. Plate No.      shows two middle sections, one 25 days old and one 50 days old. A notable feature of the roots on the 25-day-old section is that they are simple straight roots, not branched and white in color. These function in a manner similar to tap roots and may be regarded as modified tap roots. The roots on the 50-day-old section are branched and have the typical orange-red color. All of the roots in both sections arise deep in the tissues of the leaf rather than on the surface, though the mass of red branched roots is closer to the surface than are the white unbranched roots. The 50-day-old section shows no signs of forming rhizomes even though the mass of fibrous roots is large.

Once the tip and middle sections begin to form roots, the portion above ground acts as a new plant, furnishing a supply of plant food to the root system which rapidly expands until a mass of roots is formed. These sections remain green even after many new plants have been produced above ground, showing that the leaf is still active in the manufacture of plant food.

Base Sections: Base sections of the petiole require 60 to 90 days before adventitious roots appear, and even then only a few roots are formed. The lack of adventitious buds in the petiole section prevents the formation of many roots. Even after the roots are formed they usually remain small, which is probably due to the lack of chlorophyll in the petiole section. This would naturally result in less plant food with which to build a vigorous root system.

## SYSTEM OF ROOT DEVELOPMENT

In the development of new plants from leaf cuttings, three distinct growth periods or phases may be recognized. The first covers the formation of the scattered, unbranched adventitious roots, while the second signalizes the formation of a mass of branched roots characteristically red in color. Following these two periods is the formation of rhizomes and the appearance above ground of the new plant.

Like the adventitious roots, the rhizomes arise from inner bud tissue at the very base of the cut section, though just how the rhizome buds are differentiated from the other buds which form masses of fibrous roots is a physiological factor not yet clearly understood. Also, the fact that when rhizomes are planted, new rhizomes are formed without the formation of any fibrous roots is an interesting physiological phenomenon not found in the rooting of leaf cuttings, where masses of fibrous roots always precede the formation of rhizomes.

Rhizomes from rooted leaf cuttings almost invariably grow horizontally for two or three inches from the leaf section and then assume a vertical position. They are also white in color when first formed like the first unbranched roots. Thus there are three stages of specialized root development; first, white unbranched roots, followed by masses of red roots and then by white rhizomes. No roots are formed on the rhizome until the shoot appears above ground. As soon as the shoot appears above the surface of the soil lateral roots with branches form rapidly along the rhigomes. The same stage of root development is repeated on the rhizome as in the leaf section, namely, white unbranched roots are formed first, followed by many branched red-colored roots. Eventually the entire rhizome turns orange-red.

## TYPE OF PLANTS PRODUCED BY LEAF CUTTINGS

Unlike seed and rhizomes, which produce plants of the rosette or partially upright type, all of the plants obtained from whole sections of leaf cuttings are upright in form. This habit of producing upright plants is a distinct advantage from a fiber standpoint since only leaves with long petioles are suitable for fiber. The elimination of the intermediate stages of passing from rosette to upright leaves greatly shortens the period of time required to mature leaves suitable for fiber purposes. Compared with rosette plants, this growth habit of leaf cuttings shortens the growing period from planting to maturity by as much as a year or longer when a fiber leaf is the primary consideration.

## LEAF CUTTINGS SPLIT VERTICALLY

In August, 1942, before the series of experiments discussed in this paper had been planned, a few leaf sections that had been split vertically into halves, thirds, fourths and eights were planted. Only middle and tip sections were used. All of these rooted readily, but the smaller sections produced only one plant each. Also, unlike the whole sections, the smaller sections produced only rosette plants which were very small and weak. All of these sections were transplanted from a field where they were first rooted to their present location adjoining the monthly experiments. Transplanting was done during dry weather and the plants were injured severely though but few died. The present vigorous condition of these plants is shown in Plate . The rosette plants obtained from the small split-leaf sections is the only instance noted where rosette plants have been produced from leaf cuttings.

## COMMERCIAL PLANTING OF LEAF CUTTINGS

Leaf cuttings were planted experimentally on a commercial scale in the spring of 1943, but most of these plants died, due primarily to the extremely dry weather and the small size of the leaf section which caused them to rapidly dry out and shrivel in the hot, dry sandy soil. Many of the leaf sections were split vertically into small sections, which subsequent investigations have shown was an error. Also, much of the stock used was several days old, rather than freshly cut material, a factor that is detrimental where leaf cuttings are used for planting stock.

An efficient leaf-cutting machine for preparing leaf sections on a commercial scale, which is driven by a 1/4 H.P. electric motor, was designed and built by Mr. Oscar, R. Winchester. This machine is so designed that each leaf section is cut with a fork in the end which goes into the ground. This was done in order that the sections might be planted without reversing their polarity; that is, to avoid turning the sections up side down. Except in rare cases, leaf cuttings planted with the ends reversed will not root. In the experimental work that has thus far been done, not a single leaf section with the ends reversed has rooted in the field.

This leaf-cutting machine is easily operated and a large quantity of planting material can be prepared in a relatively short period of time. The length of the leaf section is readily regulated by means of an adjustable backstop, which is shown in Plate . As the sections are cut they fall into a 2-bushel crate. When the required number of crates of planting material have been prepared they are taken to the field by truck. Planting is done by hand.

Although this particular experiment was not successful, this does not necessarily mean that the use of leaf cuttings as planting stock is impracticable. Information now available indicates that if the leaves are freshly cut, properly prepared, and planted under suitable temperature and moisture conditions, a satisfactory stand of plants is likely to be obtained. The advantages of leaf cuttings for planting stock are that they are cheap, easy to plant, and will produce a large number of plants of the right type for fiber. Also, a growth of plants sufficiently dense to crowd out the weeds is obtained, which is a very important item in getting a crop of sansevieria started.

| Date of Planting | Number and Kind of Leaf Sections Planted | | | Number of Sections Dead on September 1, 1944 | | | Number of Plants Produced from all Sections of each Type of Cutting by Sept. 1, 1944 | | | Average Height in Inches of Plants Produced by each Type of Cutting - September 1, 1944 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base-Middle-Tip | | | Base-Middle-Tip | | | Base-Middle-Tip | | | Base-Middle-Tip | | |
| 7/25/43 | 60 | 50 | 50 | 25 | 10 | 30 | 22 | 75 | 50 | 6" | 10" | 12" |
| 8/25/43 | 70 | 70 | 70 | 2 | 2 | 2 | 33 | 96 | 215 | 8 | 12 | 15 |
| 9/25/43 | 100 | 100 | 100 | 43 | 25 | 25 | 24 | 65 | 152 | 8 | 8 | 12 |
| 10/25/43 | 125 | 100 | 50 | 34 | 18 | 5 | 16 | 105 | 90 | 6 | 12 | 12 |
| 11/25/43 | 150 | 75 | 40 | 96 | 18 | 24 | 5 | 50 | 32 | 4 | 6 | 6 |
| 12/26/43 | 32 | 20 | 15 | 25 | 2 | 3 | 1 | 12 | 15 | 3 | 4 | 6 |
| 1/25/44 | 50 | 30 | 20 | 5 | 3 | 2 | 2 | 25 | 25 | 2 | 5 | 6 |
| 2/25/44 | 50 | 75 | 50 | 8 | 4 | 3 | 1 | 17 | 30 | 3 | 3 | 4 |
| 3/25/44 | 75 | 50 | 35 | 8 | 2 | 5 | 3 | 4 | 21 | 2 | 2 | 3 |
| 4/25/44 | 20 | 20 | 20 | 15 | 8 | 14 | 0 | 0 | 0 | - | - | - |
| 5/25/44 | 20 | 20 | 20 | 2 | 4 | 10 | 0 | 0 | 0 | - | - | - |
| 6/25/44 | 20 | 20 | 20 | 5 | 2 | 20 | 0 | 0 | 0 | - | - | - |
| 7/25/44 | 20 | 20 | 20 | 0 | 1 | 0 | 0 | 0 | 0 | - | - | - |
| 8/25/44 | 20 | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| TOTALS | 812 | 670 | 530 | 268 | 99 | 143 | 107 | 449 | 630 | 4.66" | 6.88" | 8.44" |

# SANSEVIERIA REPRODUCTION FROM LEAF CUTTINGS

Experiments were initiated in the early summer of 1943 for the purpose of determining the feasibility of using leaf cuttings of sansevieria as a source of planting stock for possible commercial plantings. Plantings were made each month, beginning in July, to test the possible effects of different dates of planting, and different parts of the leaf were used as planting stock. The parts of the leaf used were the base of the petiole, sections from the middle of the leaf blade and the tip end of the leaf. This paper deals with the results obtained during the first 14 months of these experiments.

## Plan of Experiments

Each experiment included from 20 to 100 sections of each type of planting stock, and plantings were made on the 25th day of each month. The sections were planted 4 inches deep in a very light sandy soil in rows 6 feet wide, and were spaced 2 inches apart in the drill. All planting stock used consisted of leaves of wild plants, all of which were obtained from the same source. The sections were cut 12 inches in length and only whole cross sections of the plant were used; that is, the leaf or petiole was not split vertically in this series of experiments. In an earlier experiment, which will be discussed briefly in this paper, two rows of leaf cuttings, in which the sections were split vertically, were planted. Fresh planting stock was always used, each planting being made within two or three hours after the material had been cut. None of the plantings were watered at any time.

The tabulated results of the 14 monthly plantings are shown in table 1. In general it has been found that the best results are obtained with the tip sections, followed in turn by the middle sections of the leaf and by the petiole sections last. The petiole sections not only germinate the least satisfactorily but each section usually produces only one plant, whereas, the middle and tip sections both produce several plants from each section. The number of sections of each type of material planted during this period was 712 base, 570 middle and 430 tip. The number of each type that died was 246 base, 85 middle and 99 tip sections, leaving 466 base sections, 485 middle and 331 tip alive on September 1, 1944. For the first nine months only 107 plants had been produced by the 466 base sections, compared with 449 plants produced by the 485 middle sections and 650 plants by the 331 tip sections. Thus, for the first nine months the base sections averaged less than one plant per four sections, whereas, the middle sections averaged almost one plant per section and the tips almost two plants per section. The tip section has consistently given the best results. Not only does the tip section produce more plants, but also it roots the most rapidly and the plants grow more rapidly than those produced by the middle and basal sections. In some cases, sections of all three types were still alive on September 1, 1944, but had not produced any plants above ground. It is possible, therefore, that the number of plants ultimately obtained from each type of material may vary somewhat from the present records of production. It appears unlikely, however, that the basal sections will ever approach the averages of the middle and tip sections.

## LENGTH OF TIME REQUIRED TO PRODUCE ROOTS, RHIZOMES AND PLANTS

Tips: Under favorable conditions tip sections will produce roots in 20 days and rhizomes in 70 to 90 days. Also under favorable conditions, from 90 to 120 days will elapse before new plants appear above ground from rooted cuttings. During the dry winter and spring months, as shown in table 1, this period may be as long as five months. From January until July, 1944, was an extremely dry period and no plants appeared above ground from any of the monthly plantings made after March of this period, although adventitious roots formed on many sections of cuttings planted in April, May, June and July. It is believed that insufficient moisture prevented the formation of rhizomes from which the new plants are formed.

Middle Sections: The results obtained with middle sections of the leaf are in general similar to the results obtained with the tips, except that adventitious roots form a little more slowly than with the tip sections. Also, rhizomes are formed a little more slowly, and the number of rhizomes produced by a section of given size are less than with a tip section of the same size. Plate No. shows two middle sections, one 25 days old and one 50 days old. A notable feature of the roots on the 25-day-old section is that they are simple straight roots, not branched and white in color. These function in a manner similar to tap roots and may be regarded as modified tap roots. The roots on the 50-day-old section are branched and have the typical orange-red color. All of the roots in both sections arise deep in the tissues of the leaf rather than on the surface, though the mass of red branched roots is closer to the surface than are the white unbranched roots. The 50-day-old section shows no signs of forming rhizomes even though the mass of fibrous roots is large.

Once the tip and middle sections begin to form roots, the portion above ground acts as a new plant, furnishing a supply of plant food to the root system which rapidly expands until a mass of roots is formed. These sections remain green even after many new plants have been produced above ground, showing that the leaf is still active in the manufacture of plant food.

Base Sections: Base sections of the petiole require 60 to 90 days before adventitious roots appear, and even then only a few roots are formed. The lack of adventitious buds in the petiole section prevents the formation of many roots. Even after the roots are formed they usually remain small, which is probably due to the lack of chlorophyll in the petiole section. This would naturally result in less plant food with which to build a vigorous root system.

## SYSTEM OF ROOT DEVELOPMENT

In the development of new plants from leaf cuttings, three distinct growth periods or phases may be recognized. The first covers the formation of the scattered, unbranched adventitious roots, while the second signalizes the formation of a mass of branched roots characteristically red in color. Following these two periods is the formation of rhizomes and the appearance above ground of the new plant.

Like the adventitious roots, the rhizomes arise from inner bud tissue at the very base of the cut section, though just how the rhizome buds are differentiated from the other buds which form masses of fibrous roots is a physiological factor not yet clearly understood. Also, the fact that when rhizomes are planted, new rhizomes are formed without the formation of any fibrous roots is an interesting physiological phenomenon not found in the rooting of leaf cuttings, where masses of fibrous roots always precede the formation of rhizomes.

Rhizomes from rooted leaf cuttings almost invariably grow horizontally for two or three inches from the leaf section and then assume a vertical position. They are also white in color when first formed like the first unbranched roots. Thus there are three stages of specialized root development; first, white unbranched roots, followed by masses of red roots and then by white rhizomes. No roots are formed on the rhizome until the shoot appears above ground. As soon as the shoot appears above the surface of the soil lateral roots with branches form rapidly along the rhigomes. The same stage of root development is repeated on the rhizome as in the leaf section, namely, white unbranched roots are formed first, followed by many branched red-colored roots. Eventually the entire rhizome turns orange-red.

## TYPE OF PLANTS PRODUCED BY LEAF CUTTINGS

Unlike seed and rhizomes, which produce plants of the rosette or partially upright type, all of the plants obtained from whole sections of leaf cuttings are upright in form. This habit of producing upright plants is a distinct advantage from a fiber standpoint since only leaves with long petioles are suitable for fiber. The elimination of the intermediate stages of passing from rosette to upright leaves greatly shortens the period of time required to mature leaves suitable for fiber purposes. Compared with rosette plants, this growth habit of leaf cuttings shortens the growing period from planting to maturity by as much as a year or longer when a fiber leaf is the primary consideration.

## LEAF CUTTINGS SPLIT VERTICALLY

In August, 1942, before the series of experiments discussed in this paper had been planned, a few leaf sections that had been split vertically into halves, thirds, fourths and eights were planted. Only middle and tip sections were used. All of these rooted readily, but the smaller sections produced only one plant each. Also, unlike the whole sections, the smaller sections produced only rosette plants which were very small and weak. All of these sections were transplanted from a field where they were first rooted to their present location adjoining the monthly experiments. Transplanting was done during dry weather and the plants were injured severely though but few died. The present vigorous condition of these plants is shown in Plate . The rosette plants obtained from the small split-leaf sections is the only instance noted where rosette plants have been produced from leaf cuttings.

## COMMERCIAL PLANTING OF LEAF CUTTINGS

Leaf cuttings were planted experimentally on a commercial scale in the spring of 1943, but most of these plants died, due primarily to the extremely dry weather and the small size of the leaf section which caused them to rapidly dry out and shrivel in the hot, dry sandy soil. Many of the leaf sections were split vertically into small sections, which subsequent investigations have shown was an error. Also, much of the stock used was several days old, rather than freshly cut material, a factor that is detrimental where leaf cuttings are used for planting stock.

An efficient leaf-cutting machine for preparing leaf sections on a commercial scale, which is driven by a 1/4 H.P. electric motor, was designed and built by Mr. Oscar, R. Winchester. This machine is so designed that each leaf section is cut with a fork in the end which goes into the ground. This was done in order that the sections might be planted without reversing their polarity; that is, to avoid turning the sections up side down. Except in rare cases, leaf cuttings planted with the ends reversed will not root. In the experimental work that has thus far been done, not a single leaf section with the ends reversed has rooted in the field.

This leaf-cutting machine is easily operated and a large quantity of planting material can be prepared in a relatively short period of time. The length of the leaf section is readily regulated by means of an adjustable backstop, which is shown in Plate . As the sections are cut they fall into a 2-bushel crate. When the required number of crates of planting material have been prepared they are taken to the field by truck. Planting is done by hand.

Although this particular experiment was not successful, this does not necessarily mean that the use of leaf cuttings as planting stock is impracticable. Information now available indicates that if the leaves are freshly cut, properly prepared, and planted under suitable temperature and moisture conditions, a satisfactory stand of plants is likely to be obtained. The advantages of leaf cuttings for planting stock are that they are cheap, easy to plant, and will produce a large number of plants of the right type for fiber. Also, a growth of plants sufficiently dense to crowd out the weeds is obtained, which is a very important item in getting a crop of sansevieria started.

| Date of Planting | Number and Kind of Leaf Sections Planted | | | Number of Sections Dead on September 1, 1944 | | | Number of Plants Produced from all Sections of each Type of Cutting by Sept. 1, 1944 | | | Average Height in Inches of Plants Produced by each Type of Cutting - September 1, 1944 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base-Middle-Tip | | | Base-Middle-Tip | | | Base-Middle-Tip | | | Base-Middle-Tip | | |
| 7/25/43 | 60 | 50 | 50 | 25 | 10 | 30 | 22 | 75 | 50 | 6" | 10" | 12" |
| 8/25/43 | 70 | 70 | 70 | 2 | 2 | 2 | 33 | 96 | 215 | 8 | 12 | 15 |
| 9/25/43 | 100 | 100 | 100 | 43 | 25 | 25 | 24 | 65 | 152 | 8 | 8 | 12 |
| 10/25/43 | 125 | 100 | 50 | 34 | 18 | 5 | 16 | 105 | 90 | 6 | 12 | 12 |
| 11/25/43 | 150 | 75 | 40 | 96 | 18 | 24 | 5 | 50 | 32 | 4 | 6 | 6 |
| 12/26/43 | 32 | 20 | 15 | 25 | 2 | 3 | 1 | 12 | 15 | 3 | 4 | 6 |
| 1/25/44 | 50 | 30 | 20 | 5 | 3 | 2 | 2 | 25 | 25 | 2 | 5 | 6 |
| 2/25/44 | 50 | 75 | 50 | 8 | 4 | 3 | 1 | 17 | 30 | 3 | 3 | 4 |
| 3/25/44 | 75 | 50 | 35 | 8 | 2 | 5 | 3 | 4 | 21 | 2 | 2 | 3 |
| 4/25/44 | 20 | 20 | 20 | 15 | 8 | 14 | 0 | 0 | 0 | - | - | - |
| 5/25/44 | 20 | 20 | 20 | 2 | 4 | 10 | 0 | 0 | 0 | - | - | - |
| 6/25/44 | 20 | 20 | 20 | 5 | 2 | 20 | 0 | 0 | 0 | - | - | - |
| 7/25/44 | 20 | 20 | 20 | 0 | 1 | 0 | 0 | 0 | 0 | - | - | - |
| 8/25/44 | 20 | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| TOTALS | 812 | 670 | 530 | 268 | 99 | 143 | 107 | 449 | 630 | 4.66" | 6.88" | 8.44" |